SCIENCE ABSTRACTS.

Section A.—PHYSICS.

APRIL 1908.

GENERAL PHYSICS.

536. *Rohrdanz's New Pressure Anemograph.* **M. M. Rykačev.** (Acad. Sci. St. Pétersbourg, Bull. 14. pp. 581–601, Oct. 15, 1907. Zeitschr. Instrumentenk. 28. pp. 41–47, Feb., 1908. Translation.)—The wind presses against a vertically mounted square plate and pushes back the horizontal rod to which it is attached; this portion is above the vane which runs in a roller bearing. The motion of the plate is, by means of levers, transferred to a beam, from which the weight P_2 is suspended on the one side, while weights P_3 and P_4 are adjustably fixed on the other side; P_3 on the beam itself, P_4 on an inclined rod, radial to the knife-edge of the beam. The tilting of the beam is recorded on a drum driven by clockwork. When fixing the scale of the instrument, E. H. Rosenthal replaced P_2 by a pan which was loaded with weights. The wind direction is recorded on the Adie-Munroe method. The instrument was erected in Nov., 1906, at the Central Observatory, 30 m. above the ground. On the same tower is, further, a Freiberg-Richard anemograph, and comparative determinations of the wind velocity have been carried out in order to test the formula $p = ksv^2$, in which p is the wind pressure in kg./m.^{2}, s the area of the plate in m.^{2}, v the wind velocity in m./sec., and k a constant. The product ks proves fairly constant, but increases a little at higher wind velocities; the s being in the Rohrdanz instrument 0·040m.^{2}, the mean value of ks was 0·0035; it rose to 0·0037 when the wind velocity exceeded 12·5 m. With feeble winds of 4·2 m., ks was 0·0045; the average for winds of from 6 to 11 m. seems to be 0·0033. The resulting pressure for a wind of 1 m./sec. acting upon a plate of 1 m.^{2} would be $p = 0{\cdot}088$ kg., in satisfactory agreement with Hagen, Dines, and Langley. H. B.

537. *The Aerodromometer.* **H. Zwaardemaker.** (Zeitschr. Instrumentenk. 28. pp. 17–20, Jan., 1908.)—The author describes a simple instrument for measuring and recording the velocity of feeble air currents, such as the human breath. In the centre of a vertical glass tube, 25 cm. high, 1 or 2 cm. in diam., an aluminium disc is suspended by means of an upper and a lower spiral; the air enters and leaves through passages at the top and bottom. The disc does not quite close the tube, but leaves an annular clearance of 2·5 mm. in breath experiments; greater sensitiveness is

obtained when the clearance is reduced to 0·5 mm. The instrument is standardised by means of a continuous air-current; its use is recommended for recording rapidly alternating air-currents. Its reliability is shown by comparison with the breath-volume recorder, according to J. T. ten Have. A pendulum is so placed between two of the latter instruments, each combined with an aerodromometer, that synchronous curves are obtained. D. B. Kragenaar, of Utrecht, supplies these aerodromometers.
H. B.

538. *Standardisation of Divided Scales.* **C. E. Guillaume.** (Ann. des Poids et Mesures, 13. pp. *e*3–*e*54, 1907.)—There are three factors in a complete determination: (1) The formula of thermal expansion; (2) the total length; (3) the calibration of the divisions, *i.e.*, the differences in the distances between successive divisions. The theory is fully investigated, and certain examples are given in this paper. The author considers that the third factor above need not nowadays introduce greater error than 0·1 μ throughout the metre scale. But uncertainties in temperature and in the expansion formula bring up the error to 0·2 μ or 0·3 μ. P. E. S.

539. *Direct Determination of the Absolute Weight of a Body in Air.* **N. A. Gezechus [Hesehus].** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 39. No. 8. pp. 201–203, 1907.)—This determination can be made by two sets of weights, one set having a high density, d_1, and the other a low density, d_2. If p and d represent the weight and density of the body to be weighed and p_1 and p_2 the respective weights of the weights of densities d_1 and d_2 employed, then (1) $p = p_1 + p_2$, and (2) $p/d = p_1/d_1 + p_2/d_2$. From these two equations is derived the expression $p_1/p_2 = d_1(d - d_2)/d_2(d_1 - d)$, which indicates how many times the weight p_1 should be greater or less than the weight p_2. To avoid the inconvenience of using very small weights, the movable rider on the beam of the balance may be replaced by an arrow, one half of which consists of an Al wire and the other half of a tube of the same metal; the dimensions of the tube should be identical with those of the wire, in order that the influence of the air may be avoided. By turning this arrow in one direction or the other, equilibrium may be quickly attained. A calibrated plate placed beside the arrow indicates the weight corresponding with the deviation of the arrow. T. H. P.

540. *Standardisation of a Set of Weights.* **J. R. Benoit.** (Ann. des Poids et Mesures, 13. pp. *f*1–*f*47, 1907.)—Here the theory of numbers is employed in the usual ways; and a very elaborate set of partial standardisations are made. A set of 24 pieces from 500 gm. to 0·001 gm. are thus evaluated—each to 0·0000001 gm. The volumes of these weights are also given to 0·0001 microlitre. P. E. S.

541. *Measurement of Angular Velocity of a Shaft.* **A. Lo Surdo.** (N. Cimento, 14. pp. 448–455, Nov., 1907.)—Describes a method whereby a continuous indication of the speed of a shaft may be obtained even when the energy available is small. The shaft is made to turn a sphere by means of a friction wheel about an axis parallel to the shaft. Another shaft, driven at a known speed, communicates to the sphere a simultaneous motion about an axis at right angles to the first shaft. Both the axes of motion of the sphere are horizontal, and the sphere rests freely on a friction wheel. Under these

circumstances the top of the sphere moves in a direction which depends upon the relative speed of the two motions. If they are equal, the instantaneous summit moves in a direction making an angle of 45° with either axis of motion. The actual angle is indicated by a pointer attached to a small wheel which runs lightly on the top of the sphere, or rather a little below it. The contrivance is specially designed for anemometers and other meteorological instruments. E. E. F.

542. *Elastic Impact.* **de Maupeou.** (Annal. Soc. Sci. de Bruxelles, 32. 1. pp. 1–24, 1907–1908.)—Upon analysis of the longitudinal impact of two long bars, the author is led to the conclusion that in the case when one of the bars is stationary the other should not rebound with a velocity equal to its striking velocity, as given by the usual analysis, but should remain stationary after the impact. In the case considered the bar initially at rest is four times the length of the other. Experiments on iron bars of several length ratios closely confirm the result. Velocities corresponding to heights of fall under gravity of 1, 2, and 3 m. were used. The mean velocity of propagation of stress calculated was 5,150 m. per sec. Torsion experiments were also carried out, the falling bar striking a crank fixed to one end of the bar to be strained in torsion. The mean velocity of propagation was 3,450 m. per sec. Hence the ratio of the two moduli was as the square of these velocities, or 0·44. The motion of points on the bar was recorded on a drum rotated by a small electric motor, by pointers attached to the bars. Jerks in the records distinctly indicate the moments at which the waves pass the points of attachment. The reflections continue a number of times before complex action smooths the jerks from the curve. F. R.

543. *Effect of Combined Stresses on Steel.* **E. L. Hancock.** (Phil. Mag. 15. pp. 214–222, Feb., 1908. Paper read before the Amer. Soc. for Testing Materials, June 20, 1907.)—The following are the results of torsion tests of steel tubing 1 in. external and 0·875 in. internal diam., whilst under definite tensions or compressions :—

Tension or Compression Stress Applied.	Elastic Limit in Torsion, lbs. per sq. in.	Modulus of Rigidity, lbs. per sq. in.
0	10,500	10,350,000
0·33 of tensile elastic limit	7,200	9,075,000
0·50 „ „ „	6,800	10,350,000
0·89 „ „ „	4,500	9,075,000
0·81 „ „ „	3,300	9,680,000
Equal to „ „ „	2,700	8,086,000
0·33 of compressive elastic limit	7,700	7,000,000
0·50 „ „ „	4,500	7,500,000
0·88 „ „ „	3,800	4,200,000
Equal to „ „ „	2,900	5,000,000

Combined torsion and bending of shafts 1½ in. diam. gave results as follows in lbs. per sq. in.: Mild steel, torsional stress from 0 to 38,000; elastic limit in bending, from 47,000 to 22,500; modulus of elasticity in bending, from $32{\cdot}9 \times 10^6$ to $31{\cdot}5 \times 10^6$, including a value $28{\cdot}4 \times 10^6$. Three per cent. nickel steel, torsional stress, from 0 to 38,000; elastic limit in bending, 78,500 to

84,000 ; elastic modulus in bending, $33·3 \times 10^6$ to $32·3 \times 10^6$, including a value $27·7 \times 10^6$. In only a few cases does the max. tension, as computed from the applied loads, exceed the tensile strength of the material as found in tensile stress tests. On the other hand, the computed max. shear is in many cases greater than the shearing strength of the material. F. R.

544. *Stresses in Plate Girders.* **F. E. Turneaure.** (West. Soc. Engin., Journ. 12. pp. 788–812 ; Discussion, pp. 813–819, Dec., 1907.)—Extensometer observations made on the stiffeners of a railway bridge of 75 ft. span and 7 ft. 6 in. depth of plate girders showed that under ordinary working conditions the axial stresses in intermediate stiffeners were small—practically zero—but that there was some bending, which proves that they assist in supporting the web. At points of concentration of load—ends and points of attachment of cross-beams—considerable direct stresses occurred in stiffeners. The results of experiments made on a specially constructed girder, of 16 ft. span, 2 ft. depth, 0·14 in. web thickness, with angle-iron flanges, are given in detail, with photographs of the ultimate failure which occurred by buckling, and tearing at right angles to the wrinkles, in the end panel, which had an unsupported depth of 14 in. and length 2 ft. 7 in. Failure of elasticity in web occurred with a max. shearing force of 30,000 lbs., considerable permanent buckling at 75,000 to 80,000 lbs. shear, and final failure at 104,700 lbs. shear. The corresponding average shearing stresses in the web, on the usual assumptions, are 9,930, 26,500, and 34,700 lbs. per sq. in. respectively. It is concluded that the stresses in web plates without or with stiffeners stressed within the elastic limit agree closely with theoretical stresses. Hence the axial stresses in vertical stiffeners not affected by local loads are practically zero. In the present case the strength of web without stiffeners was twice that calculated by Euler's formula applied to a diagonal element. If the strength of web plate without stiffeners may be assumed to vary as $(t/l)^2$, then the common practice of omitting stiffeners when $t/l > 1/60$ is sufficiently accurate. In the *discussion*, **A. Smith** contributed tests of similar nature to those of the author, which confirmed several points. He observed that after the passage of a train the reading of the extensometer on a stiffener took several seconds to return to zero ; this is probably due to slip of the rivets. F. R.

545. *Cold-rolled and Cold-drawn Steel Bars.* **A. J. Wood.** (Eng. News, 59. pp. 63–64, Jan. 16, 1908.)—Ordinary hot-rolled bars having 30·3 per cent. elongation on 8 in. gave when cold-drawn 8·75 per cent. elongation, elastic limit raised 100 per cent., and max. stress raised by 10 to 15 per cent. Tensile tests showed little difference between the effects of cold drawing and cold rolling. It is pointed out that a hot-rolled bar overstrained in tension to such an extent that its elongation was 12 per cent., had its elastic limit raised by about 30 per cent. only. Cold-drawn bars were tested after turning down from the drawn size to various diameters, and the results showed no appreciable change in elastic limit or max. stress. Microscopic examination showed no difference in structure between different parts of the section of cold-drawn bars. F. R.

546. *Tests of Carbon-Steel and Nickel-Steel Columns.* **J. A. L. Waddell.** (Eng. News, 59. pp. 60–64, Jan. 16, 1908.)—Gives results of tests of twelve columns consisting of two built-up channels connected by lattice details, having pin ends. The following table gives the results, each being the average of three tests. The area of cross-section of metal was in each case 17·44 sq. in., and radius of gyration (*r*), 4·46 in.

	MATERIAL.		COLUMNS.			
	Elastic Limit, lbs. per sq. in.	Tensile Strength, lbs. per sq. in.	Length, *l*, inches.	*l*/*r*.	Elastic Limit, lbs. per sq. in.	Ultimate Strength, lbs. per sq. in.
Carbon Steel	Not less than 35,000	60,000 to 70,000	120 360	27 81	28,800 21,300	39,200 30,500
3·5 per cent. Nickel Steel	Not less than 60,000	100,000 to 115,000	120 360	27 81	52,800 41,200	68,700 44,700

The author's formulæ for pin-ended struts, which are sufficiently confirmed by these tests, for permissible stress (I) are, for carbon steel columns, $I = 16{,}000 - 80\,l/r$, and for nickel steel columns, $I = 27{,}000 - 160\,l/r$. The tests are discussed in detail in comparison with the results given by Buchanan [Abstract No. 377 (1908)]. F. R.

547. *Elongation in Rolling.* **E. Cotel.** (Stahl u. Eisen, 28. pp. 162–164, Jan. 29, 1908.)—As a result of an experiment the author finds that the metal coming through the rolls never outstrips the latter—*i.e.*, never issues with a velocity higher than the peripheral velocity of the rolls. The statement in a standard book, that the greater the reduction the greater the outstripping, is erroneous. In reply to **J. Puppe** further details are given, and another experiment is recorded. In both experiments there was a small difference in diam. of upper and lower rolls, and the length of rolled bar corresponding to one revolution of the rolls was something between the circumferences of top and bottom rolls. F. R.

548. *Winding Ropes and Safety Appliances in Mine Shafts.* (Eng. News, 58. pp. 462–465, Oct. 31; 492–494, Nov. 7; 509–511, Nov. 14; 548–549, Nov. 21, and pp. 604–608, Dec. 5, 1907. Report of Transvaal Commission. Mech. Eng. 20. pp. 774–777, Nov. 30; 807–810, Dec. 7, and pp. 835–840, Dec. 14, 1907. Abstract. Engineering, 85. pp. 201–202, Feb. 14, and pp. 327–329, March 13, 1908.)—In the section of this report which deals with the material of winding ropes, it is stated that it has been found that wires which are in reality inferior for use in ropes, although they withstand tension or torsion or bending tests sufficiently well, have had their inferiority disclosed when tested under combined tension, torsion, and bending rapidly repeated. Drawings and a description of a machine designed by J. A. Vaughan and W. M. Epton for the purpose of carrying out such tests are given. For the Rand, manufacturers recommend wire of from 105 to 135 tons (of 2,000 lbs.) per sq. in. tensile strength; 120-ton steel is most commonly used. The lower limit is for unfavourable conditions, *e.g.*, as to bending stresses; the higher for very favourable cases. 150-ton material has given satisfactory results in particular instances. No manufacturer appears to be able to recommend nickel steel or vanadium steel for ropes. Experiments by Epton and Moir as to the effect of galvanising "plough" steel wire show that the tensile strength is not lowered, elongation is doubled, the number of complete twists required for rupture is reduced 20 per cent., and the number of alternate bendings to fracture is reduced 25 per cent. by galvanising. The resistance of partly galvanised wire (to imitate a galvanised wire with the zinc coating worn through) to corrosion in dilute acids was 8 times that of bare wire, and the resistance of galvanised wire completely coated was 80 times that of bare wire. Heymann's experiments tend to show that the corrosion of wire is primarily due to the atmosphere, especially when deleterious gases are present, rather than to even the most impure mine water. A minimum factor of safety of 6 is recommended for winding ropes, with no reduction for very long ropes, as the Commission considers that those factors which are independent of length, particularly bending stresses, are too important to be neglected, although considerable uncertainty on these points remains yet to be removed. F. R.

549. *Bond in Reinforced Concrete.* **J. L. Van Ornum.** (Eng. News, 59. p. 142, Feb. 6, 1908.)—Plain round bars were pulled from 12-in. square prisms of 1 : 2 : 4 concrete, 90 days old, in which they had been embedded for a length equal to 25 times their diam. in the case of medium steel of elastic limit about 39,000 lbs. per sq. in., or 40 times in the case of higher carbon steel, elastic limit 53,000–60,000 lbs. per sq. in. The following summarises the results; the figures express the max. pull sustained, in lbs. per sq. in. of embedded surface :—

Diam. of bar, inches	½	⅝	¾	1	1¼
Medium steel	460	430	370	390	390
High carbon steel	400	370	390	470	330

In every case the max. pull was greater than the elastic limit load on the steel. After slipping had occurred the load fell to about 60 to 80 per cent. of the max. value. F. R.

550. *Sea Waves.* **A. Pochettino.** (N. Cimento, 14. pp. 421–447, Nov., 1907. Paper read before the Congresso delle Scienze in Parma.)—Discusses the theory of water-waves, and shows where its assumptions differ from reality, notably in the presence of air, and the fact that the motion of a drop is never a closed curved. The types of waves discussed include wind waves, free (residual) waves, stationary waves, solitary waves, librations, and seiches. A summary is given of the various methods proposed for measuring the length, height, speed, and period of waves. The lengths of ocean waves generated by wind range from 60 to 230 m. (or even 800 m.). The speeds observed range from 7 to 34·8 m. per sec. The maximum wave-height observed in the Atlantic is 16 m. (or 30 m.), in the Mediterranean 5 m. The phenomenon, styled "Dodwand" by the Dutch, consisting in a retardation of the vessel, accompanied by difficulty in steering, is found at mouths of large rivers. It is due to a thin layer of fresh water overlying the salt water of the sea. The retardation is due to waves on the limiting surface of the salt water, and the difficulty of steering is due to the fact that the vessel carries a bulk of the fresh water along with it, and the rudder, dipping into that bulk, gets no grip on the water. E. E. F.

551. *Stresses in Masonry Dams.* **H. M. Martin, O. J. Lodge, K. Pearson.** (Nature, 77. pp. 269–270, Jan. 23, 1908.)—Martin replies to E. Brown's criticism of a previous note [see Abstract No. 879 (1908)]. Lodge inquires whether the experiments on gelatine models of masonry dams do not ignore the weight of the materials—a factor on which the stability of actual dams is calculated largely to depend. K. Pearson replies to Martin, Lodge, and Brown. He states that in the experiments the weight of the dam was fully considered and experimentally determined. He criticises the engineers' method of estimating stresses in a dam, saying the method is no approximation at all, and that if it were they have neglected to apply their own conditions to the vertical sections, in which case they would have found any existing dam lacking in stability—a fact which proves the theory is wrong. Far better results should be obtained by applying the uniplanar equations of stress than by any attempt to deal with a solid practically as broad as long by a theory of flexure. **K. Pearson** (Ibid. pp. 866–867). A. W.

552. *Viscosity of Water at very Low Rates of Shear.* **L. E. Gurney.** (Phys. Rev. 26. pp. 98–122, Jan., 1908.)—Duff has found that the viscosity of water remains constant when the rate of shear varies between 5 and 500,000 radians per sec. [Abstract No. 1333 (1905)]. The object of the present experiments is to test this conclusion and to extend the investigation to lower rates of shear. The method of Couette is used; an outer hollow cylinder contains the liquid and is mounted on a turntable which revolves with constant angular velocity. An inner cylinder is supported in a concentric position by means of a vertical wire, being so placed that it is entirely covered by water. When the outer cylinder is rotated the inner experiences a couple due to the viscosity of the water. This couple is measured in terms of the constants of the wire and the viscosity can be then found. The advantage of the method is that if the dimensions of the apparatus be suitably chosen the rate of shear throughout the water is nearly uniform. The effects of the ends of the inner cylinder are eliminated by using cylinders of different lengths. Rates of shear less than 0·663 radian per sec. are not used on account of the disturbing effects of convection currents and the time that elapses before the deflection reaches its final value. The theory of the various errors is thoroughly discussed; the most important is a kind of surface rigidity of the water where the suspension enters it. The couple produced by this is in some cases greater than that arising from viscosity. Means are found to eliminate this, viz., by allowing a strip of metal, bent into a circle about the stem and fastened to an external support, to touch the surface of the water. The average value of η is about 0·8 per cent. higher than that given by Landolt and Bornstein. The author does not feel that the results justify the claim that the viscosity of water is greater at these low rates of shear, but does believe they justify the counter-claim that it is not more than 1 per cent. greater, if at all. [See also next Abstract.] R. S. W.

553. *Viscosity of Water as affected by Soluble Constituents of Glass.* **L. E. Gurney.** (Phys. Rev. 26. pp. 123–124, Jan., 1908.)—Using the method of flow through horizontal tubes with very small heads, Duff has come to the conclusion that very minute quantities of the constituents of glass dissolved out by water have very large effects on the viscosity of the water at low rates of shear [Abstract No. 1333 (1905)]. The author has allowed water to stand in contact with powdered glass for a week and has then compared its viscosity with that of pure water [see preceding Abstract]. The difference is less than can be accounted for by observational errors. R. S. W.

554. *Viscosity of Air.* **J. H. Grindley** and **A. H. Gibson.** (Roy. Soc., Proc. Ser. A. 80. pp. 114–139, Feb. 13, 1908.)—Describes experiments on a large scale for determining the coefficient of viscosity of air and other gases and the variation of this coefficient with temperature. Air was forced from a gas-holder through about 190 ft. of lead tube wound on a drum, a spiral groove having been cut to receive it. The tube was about ⅛ in. internal diam. The pressures were observed at two points with about 108 ft. of tube between, the tube being straightened at the two points. The drum with the tube on it could be heated or cooled in a large vessel of water. Observations were taken both above and below the critical velocity, the critical velocity being the velocity of flow below which the motion is steady or stream-line and above which the motion becomes eddying or turbulent, the laws of resistance being different in the two cases. The results obtained are as follows: (1) The coefficient of viscosity, μ, of dry air at 0° C. is 0·0001702 in c.g.s. units. (2) The law of variation of μ with temperature between the limits 0° C. and 100° C. is represented by an equation of the form $\mu = \mathrm{KT}^{\frac{1}{2}}/(1 + \mathrm{CT}^{-1})$, where K and C are constants and T is the absolute temperature. (3) μ was found to be independent of the pressure of the air. (4) The critical velocity for the pipe used was found to be approximately 1·95 ft./sec. (5) For velocities greater than the critical velocity the resistance is independent of the pressure of air in the pipe, and is proportional to (velocity)^n, where $n = 1{\cdot}25$ for the pipe used. A. W.

555. *First Approximation of a Pre-determination of Synoptical Weather Charts.* **F. M. Exner.** (Meteorolog. Zeitschr. 25. pp. 57–67, Feb., 1908.)—The author develops the formulæ of his second paper [see Abstract No. 17 (1908)], and applies them. In the first instance he calculates the synoptical weather chart of the United States for Jan. 3, 1895, for the interval 8 p.m. to 12 p.m., from the charts for the interval 4 p.m. to 8 p.m. of the same day. The agreement is satisfactory. He then takes the Vienna charts for Jan. 1 and 2 of the ten years, 1898 to 1907, in order to pre-determine the charts for Jan. 3; charts are issued at intervals of 24 hours only at Vienna. Eight of these ten pre-determinations are fairly satisfactory. The two unsatisfactory cases, Jan. 3, 1899 and 1902, were characterised by a deep depression lying over the N.W. of Europe on Jan. 1 and 2, which flattened out on Jan. 3; the author's calculations did not indicate this result. In this and a few other cases the method failed evidently because the author had to deal with strongly curved isobars; he does not see how he can allow for centrifugal forces. The difficulty might be overcome if we could introduce the *dQ/dt* as function of the wind direction, *i.e.*, pressure gradient; he had assumed it to be locally constant. H. B.

556. *Terrestrial Precipitation, Run-off, and Evaporation.* **E. Brückner.** (Meteorolog. Zeitschr. 25. pp. 32–35, Jan., 1908.)—In 1887 John Murray had estimated the rainfall and the water discharge of 33 rivers, from which he derived a run-off coefficient of 22 per cent. for the whole earth. His figures were based upon the rain charts of Loomis, and formed the foundation for the author's estimate of 1905 of the terrestrial water circulation. In 1906 R. Fritzsche (dissertations of above title, Halle) repeated Murray's computations, accepting Supan's rain charts. In 1907 F. v. Kerner presented a "Revision of the Zonal Precipitation" to the Geographical Society of Vienna (Mitt. 1907, pp. 139–164), and a similar treatment of the problem had been given by J. Bezdek (Soc. Hongroise de Géogr., 1904, p. 283). The author reviews these memoirs, dealing chiefly with Fritzsche, who proceeded on Murray's lines, but considered 52 rivers and also the evaporation by the author's method. The rain estimates of Fritzsche for the land and sea areas are all smaller than Murray's, but the final results for the circulation of the water differ little from the author's values of 1905. The annual balance is based upon the two equations: Rainfall on sea = evaporation from sea − river discharge; rainfall on land = evaporation from land + river discharge. About $\frac{1}{5}$ or $\frac{1}{4}$ of the total terrestrial rainfall would appear to be due to evaporation from land; the oceans are not the only source to be considered. The ratio: evaporation from land to evaporation from sea is 2·9 (Brückner's previous value 2·8); the mean evaporation from the continents amounts to 55 cm.; 61 cm. are allowed for the evaporation from the principal areas, and 33 cm. from the areas which do not discharge their rains through rivers. The author accentuates these distinctions. In the last-mentioned areas all the rain re-evaporates. The oceans receive 92 per cent. of their evaporated water back as rain; the peripheral land areas receive 143 per cent. of their evaporations in rain, and 70 per cent. of their rain comes from the land itself. v. Kerner starts from rain profiles for every fifth degree of latitude, and further separates the Old and the New World. In the Old World the eastern portion receives abundant monsoon rains in the subtropical belt, while the western portion is comparatively dry; above 40° lat. this relation is reversed. Fritzsche's figures are considered more reliable than v. Kerner's. H. B.

557. *The Long Föhn Period of October,* 1907, *and the Föhn Barometer.* **W. Trabert.** (Meteorolog. Zeitschr. 25. pp. 1–9, Jan., 1908.)—Innsbruck enjoyed a long spell of fine weather from Sept. 7–25, followed by a Föhn period lasting nearly a month, with 18 pronounced Föhn days. It is commonly assumed that the Alps act as a barrier, producing an excess of pressure on the southern side. With a low barometer in the W. and a high barometer in the E., the isobars would, if there were no Alps, run straight S. to N. The Alps deflect the 760 isobar to the W. immediately south of the Alps and to the E. north of them, and produce very steep gradients, the pressure-difference on the two sides of the Alps amounting in this case to as much as 6 mm. H. v. Ficker had, however, pointed out that the barometric anomalies, the noses or wedges of high pressure, might merely be temperature effects. Studying the barometer data of the 18 days for 14 stations in the Alps, and further, the temperature and hygrometer data for Innsbruck—the temperatures at the various stations are too much subject to local influences to allow of reduction—the author concludes that the pressure-differences would be accounted for by the assumption that the air N. of the Alps was 3° or 4° C. warmer than the air S. of the Alps. H. B.

558. *The Lagging of Temperature-changes at Great Heights behind those at the Earth's Surface; Pressure-changes at Different Levels.* **H. H. Clayton.** (Monthly Weather Rev. 35. pp. 457–458, Oct., 1907.)—Preliminary account of the balloon ascents conducted by S. P. Fergusson at St. Louis, April 28 to May 19, 1906, about sunset, up to heights of 15 km. It is usually assumed that changes occur first in the upper atmosphere by the overflow of the faster and cold upper currents. This is shown to be wrong, except for the strata between 500 and 1,000 m., in which, as the kite records from Blue Hill had proved, the temperature changes earlier than at the surface. At the greater heights temperature maxima and minima are later than below, at 10 km. about 24 hours later; the change does not appear to be gradual, but the data

are so far insufficient. The surface variations seem to extend up to 10 km., not to 15 km; between these heights is the inversion layer. The sea-level pressure does not extend to more than 2 or 3 km.; this is confirmed by cloud observations at Blue Hill. Above 3 km. the elliptical isobars of the surface become U-shaped or semicircular; the line of max. (and minimum respectively) pressure is near the place of max. temperature, hundreds of miles perhaps from the surface pressure maximum. This was pointed out by Köppen, 1888 [compare also Clayton, Abstract No. 1299 (1907)]. H. B.

559. *Föhn Winds at Wosan, Korea.* **T. Okada.** (Meteorolog. Soc. Japan, Journ. No. 4. April, 1907. Meteorolog. Zeitschr. 25. p. 88, Feb., 1908. Abstract.)—The main mountain ridge of Korea runs N. to S. Winds crossing the ridge appear to the leeward as warm, dry Föhns from the W. The Japanese Government established in 1904 several meteorological stations of the first order in Korea. One of these is at Wosan, situated on the eastern coast of Northern Korea; the mountain ridge in the W. rises to 1,500 m. Föhns are frequent there, especially in spring and late autumn; the author gives particulars of two cases—April 27, 1905, and June 26, 1904. H. B.

560. *The Isothermal Layer of the Atmosphere.* **W. H. Dines.** (Nature, 77. p. 390, Feb. 27, 1908.)—Since last June some forty balloons have been sent up in Great Britain, and the isothermal layer has been reached more than thirty times. Its average height is 35,000 ft. (10·7 km.); it is rather higher with a high barometer. The mean temperature found is −53·6° F. (−77° C.), considerably higher than the Continental mean. The extremes observed in England are −22° F., near Ditcham Park, Hants, on July 24, and −78° F., near Oxford, on Sept. 12, 1907. On the same day, Nov. 11, 1907, the temperature was −42° F. at Ditcham, at 36,000 ft. altitude, −58° F. in Oxfordshire at 38,500 ft., and −74° F. near Manchester at 37,000 ft. The existence of an isothermal layer in equilibrium in which the fall of temperature suddenly stops and in which yet such great differences of temperature occur at spots not very far from one another, is difficult to understand, especially considering the low atmospheric pressure at these heights. H. B.

561. *Investigation of the Upper Inversion Layer by Pilot Balloons.* **Nadler.** (Meteorolog. Zeitschr. 25. pp. 40–41, Jan., 1908.)—By means of nine pilot balloons launched from Munich, K. v. Bassus observed that the wind always dropped, by as much as 80 per cent. sometimes, when the balloon reached the upper inversion layer. Two further balloons of rubber, 1·9 m. in diam., sent up by the author and Bassus, likewise from Munich, in March and May, 1907, confirm this observation. A rope, 20 m., was attached to the balloon, which was watched with a Quervain's theodolite, a yellow screen being placed in front of the eyepiece, so that the balloon appeared in the evening light as a bright spot on a black sky; the height was calculated from Hergesell's formula assuming constant velocity. The first balloon burst at a height of 9·5 km. when the wind dropped by 62 per cent., from 29 to 11 m./sec.; the wind direction was E. 20° S. or E. 30° S. all the time. The second balloon burst at a height of 11·3 km., the wind, from S. or SW., dropping from 11 to 3 m./sec. The heights are probably correct within 350 m. H. B.

562. *Journey of the Balloon "Ziegler" from Rheinfelden to England, Nov. 1–3, 1907.* **K. Wegener.** (Meteorolog. Zeitschr. 25. pp. 67–73, Feb., 1908.)

—When charged with hydrogen the balloon was twice carried to England, first on April 10 and 11, 1907, then on Nov. 1-3, when it kept afloat for 40½ hours. The balloon started with the author and two others from Rheinfelden, near Basle, at 9 a.m., Nov. 1, and landed at Huntingdon, Cambridgeshire, at 1.25 a.m. on Nov. 3. The journey might have been continued. The chief interest of the paper lies in the influence of the Vosges Mountains and of the sea. The balloon came almost to a standstill near the Vosges, drifting first N., then S., and very slowly back to N. at different levels. Fearing afterwards to be carried out into the North Sea, they manœuvred and crossed the Channel between 7 and 8 p.m., *viâ* Grisnez and Folkestone. The barograph rose slowly over the sea. The balloon is not weighed down by the cold air, however, as is often stated, but loses heat by radiation when entering the cooler air over the water in daytime, and gains heat after sunset. Before reaching Folkestone the balloon stopped, having been sent up to 1,900 m. by mistake; over land it began to descend. H. B.

563. *Diurnal Heat Exchange in the Snow on the Ground.* **T. Okada.** (Monthly Weather Rev. 35. pp. 450–452, Oct., 1907. Reprint from Journ. of the Meteorolog. Soc. of Japan, April, 1907. Meteorolog. Zeitschr. 25. pp. 82–85, Feb., 1908.)—For the week Feb. 16–23 observations were taken every hour in the compound of the Kamikawa Observatory in Hokkaido, 113 m. above sea-level, lat. 43° 47′ N., mercury thermometers being vertically inserted in the snow. The snow temperatures were at 4 p.m., 1 p.m., midnight, respectively —22·65, —8·77, —13·45 at the surface; —13·9, —8·8, —11·8 at a depth of 10 cm.; —8·5, —8·95, —8·04 at 20 cm.; at 30 cm. the temperature was practically steady, —6·30° C. J. Yamada determined the density of the snow, and with the aid of Bezold's formula the heat-exchange is calculated; this exchange is practically, on snow-covered ground, confined to the upper 30 cm. of snow. For snow the average total daily heat-exchange is 19 gm.-cals. per cm.^{2}, while it is, according to J. Schubert, 15 for moor soil, 21 to 24 for sandy soil, both with growing conifers, 38 to 43 for moor meadow, 62 to 80 for sand soil, 134 for granite rock. On a clear day the heat-exchange on the snow was 24·3, on a cloudy day 11·5 gm.-cals. Reference is made to Homén, not to Westman [Abstract No. 582 (1907)]. H. B.

564. *Actinometric Observations on the Little Ararat.* **A. Woeikow.** (Meteorolog. Zeitschr. 25. pp. 38–39, Jan., 1908. Communication to the K. Russ. Geogr. Gesell., Dec. 18–31, 1907.)—F. Nesdürow, P. E. Stelling, and S. T. Suwarow made observations in Aug., 1907, on the Little Ararat, 3,800 m., and at Surdar-Bulach, 2,800 m., on the saddle leading over to the Great Ararat, 5,100 m., with a Michelson actinometer and an Ångström absolute pyrheliometer. The greatest radiation value on the Little Ararat was 1·5 cals. per cm.^{2} per min.; the maximum observed by Stankiewicz on the Pamir was 2·01 cals. The temperature minimum of 2° fell between 6 and 5 h.; the maximum of 7·5 about 13 h.; in daytime temperature fluctuations of 8° were frequent. The locality would be very favourable for systematic observations on the heights mentioned and further at Aralych, situated on the plateau at less than 1,000 m. altitude. H. B.

565. *Seismographs and Seismograms.* **R. D. Oldham.** (Nature, 77. pp. 246–247, Jan. 16, 1908.)—Discussion of relative merits of various types of seismograph. The general problems of seismology involve the determination of (1) exact nature and amount of movement which takes place; (2) time

requisite for the transmission of the different types of disturbance from the origin to various distances, in various directions, through the earth or along its surface. From the mathematical and experimental investigations of the mechanics of seismographs by Galitzin, Rudzki, and others, it has been conclusively established that no form of instrument having a pendular period of vibration of its own, however perfectly its oscillations may be damped, can possibly record with exactitude an undulatory movement of the soil such as is caused by earthquakes. As all instruments for continuous record require this movement for returning to zero, it is obvious that no single instrument will suffice for the purpose of determining the exact nature and extent of the earth movements. For the second factor, however, all that is necessary is that the main features of the disturbance should be easily recognised on all records at widely different stations, and for this purpose four instruments have been designed and are in common use—the Wiechert astatic pendulum, the Rebeur-Ehlert horizontal pendulum, the Omori pendulum, and the Milne horizontal pendulum. It is in the remarkable ease of reproduction of the records that the latter is superior to the others, thus rendering any centralisation of seismological research unnecessary. C. P. B

566. *The Earth, a Failing Structure.* **J. F. Hayford.** (Phil. Soc. Washington, Bull. 15. pp. 57–74, Dec., 1907. Address.)—The author reviews G. H. Darwin's paper of 1882 on the stresses caused in the interior of the earth by the weight of continents and mountains, in the light of subsequent research. Even granite would not stand for geological ages a stress-difference of 4 tons per sq. in.; engineers consider 0·2 ton the safe working load for granite. The heterogeneous mineral of the earth's crust will, moreover, not be so strong as continuous good granite. The high temperatures of the interior will reduce the strength of the rocks, and the stresses caused by the continents—which Darwin had assumed to be of a regular mathematical form—are probably larger than he concluded. According to the theory of isostasy the material underlying the continents is less dense than that under the oceans, while Darwin assumed the densities to be the same. The approach to perfect isostasy is so close apparently as to indicate that isostatic readjustment by failure under stress has been going on in recent geologic time during which there have been large transfers of material beneath and on the surface by erosion and deposition. The geologists find abundant evidence of failure under stress and tendency to concentrated deformation in certain regions. The larger openings of the deep mines in Michigan Peninsula are gradually closing up. Earthquakes do not furnish much evidence of the absolute strength of the earth, for accurate observations are rarely secured near the earthquake centre, but earthquakes apparently resulting from local failures are widespread and numerous. The stresses produced by the tidal forces are too small to serve as a test of the strength. There is no necessary relation between rigidity (or stiffness) and strength, and a given portion of material may behave in an elastic manner under one set of suddenly applied stresses, while yielding slowly in a non-elastic manner under other stresses acting for long periods without change of direction. In so far as our personal safety is concerned, however, the weaker the structure, the safer we are; for on a weak earth the changes are slow and not severe. H. B.

567. *Experimental Investigation of the Temperature-changes occurring in Fresh-water Lochs.* **E. M. Wedderburn.** (Roy. Soc. Edinburgh, Proc. 28. pp. 2–20, 1907–8.)—Some of the author's suggestions, and in particular the

temperature seiche of Loch Ness [see Abstract No. 588 (1907)] having been criticised, the author returns to the subject and describes some experiments. Three phases can be distinguished in Loch Ness. From Dec. to April the temperature is nearly uniform at all depths, and the depth-temperature curve a vertical line. In May to July there is first a rapid fall, then a slow fall of temperature with increasing depth, where the curve again becomes straight. In Aug. to Nov. the temperature falls very little at first, then very rapidly in the "Sprungschicht"—for which the term "discontinuity layer" is now suggested—and afterwards slowly again; the discontinuity layer sinks gradually. In the experiments a trough is used, 152 cm. long, 10·5 cm. wide, 12·5 cm. deep, with parabolic bottom and partly covered in, as in the seiche experiments of White and Watson. A rotary fan drives a blast of air along the water surface. In order to imitate temperature differences by density differences, a solution of salt or solid salt, sometimes also potassium bichromate, are introduced, and the currents are rendered visible by some black stain. The conditions would thus in a measure resemble Kalecsinsky's heat-accumulating salt lakes [see Abstracts Nos. 1292 (1902) and 3283 (1904)], to which the author does not refer. While the loch is gaining in temperature, there is a warm surface layer at the top which is carried along by the surface wind; the return current produces a gradual mixing of the discontinuity layer with the other water, so that a uniform temperature is re-established. Before this mixing takes place, a temperature seiche of a period of 10 or 20 sec. is set up, while the ordinary seiche period is 3 sec.; there is also a density bore. The discontinuity layer confines the opposite return current, so that below this layer the currents again flow more or less in the same direction as on the surface. With the aid of diagrams marking the temperature distribution in Loch Ness (depth 700 ft.) in Aug. and Sept., 1904, the author shows that surface winds induce movements at the bottom even of our deepest lochs.

H. B.

568. *Minute Structure of the Photosphere.* **S. Chevalier.** (Astrophys. Journ. 27. pp. 12–24, Jan., 1908.)—From photographs taken at Zô-sè with instruments giving very large scale images of the sun, it is found possible to study the dimensions and forms of the photospheric granules, also their method of formation and movements from time to time. Since the historic work of Janssen on the "photospheric réseau," considerable variations in the results obtained have been noted by various observers, and Hansky has pointed out that discrepancies may be largely due to atmospheric waves between the object-glass and the sun. Chevalier, however, has noticed that while the réseau is quite frequent when working with an enlarging camera, it is but seldom noticed when the photographic plate is placed direct at the focus of the refractor, thus suggesting that the peculiarities may be caused by the unequally heated air laminæ in the neighbourhood of the secondary lens used for enlargement. It is found possible to detect the individual granules on plates having a scale of 65 mm. to the solar diameter, in which case they will be about 0·08 mm. in diam. In practical details it has been found that the chloride plates are far inferior to slow bromide emulsions. Photographs are given illustrating the arrangements and movements of the granules, and a series showing the difference in character of images taken with an enlarging camera and at the principal focus with subsequent enlargement of the negative. It is readily seen that the granules are of a more or less circular or slightly elliptical form. Chevalier thinks that the dark interspaces may only be less luminous than the bright granules because they are covered by a thicker layer of chromosphere and reversing layer. The duration between the formation of a granule and its disappearance is very short. After ten minutes or so nothing remains that can be recognised on the surface of the sun except spots and faculæ. The granules move with projected horizontal velocities from zero to 30 km. per sec., but this velocity is small when the relatively great linear dimensions of the granules are considered. These movements, however, may not be real translatory motions of the granular particles, but merely an optical displacement owing to the wave motion of the disturbed upper surface layers of the photosphere. C. P. B.

569. *Calcium Compounds in Sun-spots.* **C. M. Olmsted.** (Astrophys. Journ. 27. pp. 66–69, Jan., 1908. Contribution from the Mount Wilson Solar Observatory, No. 21.)—Hale and Adams have recently shown that numerous flutings appear in spectra of sun-spots which may be ascribed to titanium oxide [see Abstract No. 804 (1907)]. Fowler has also recognised the bands of magnesium hydride. Now Olmsted shows that several prominent bands in the red region are produced by calcium vapourised in the presence of hydrogen. They do not show when the calcium arc in air is photographed. Photographs are given showing the bands at λ6382·2 and λ6389·3 in the spot spectrum and in the calcium-hydrogen arc. C. P. B.

570. *Simultaneous Observations of Jupiter.* **J. Mascart.** (Soc. Astronom. de France, Bull., 1907. Nature, 77. pp. 259–260, Jan. 16, 1908. Extract.)—About the end of 1905 observers with suitable telescopes were invited to collaborate in a scheme for simultaneous observations of the planet Jupiter on prearranged dates, and the present memoir gives the results of thirty-six observers who joined in the scheme. Drawings were to be made on every clear night from Jan. 2–20, 1906, on previously prepared white discs, the scale being such that 1 mm. on disc corresponded to about 2,000 km. on the planet. The instruments varied in aperture from 75 mm. to 380 mm. Reproductions of the drawings made are given, showing both the correspondences and divergences due to personal error. C. P. B.

571. *Disappearance of Saturn's Rings.* **E. E. Barnard.** (Astrophys. Journ. 27. pp. 35–44, Jan., 1908.)—At intervals of fifteen years the edge of the ring system of Saturn is presented directly towards the earth, and becomes at such times practically invisible. After reviewing the records of this phenomenon since 1861 the special appearances noted during the last disappearance about the autumn of 1907 are referred to. Distinct condensations were observed on portions of the ansæ, and knowing that the crape ring is transparent, if we were to look on its under side—the opposite side from the sun—at an oblique angle, we should see it luminous by the reflection of the sunlight in our direction from the small bodies composing it. The illumination would be nearly as strong as when seen from the sunward side. From the extreme thinness of the rings, probably less than 50 miles, it is evident that the particles cannot form an impenetrable screen to the sunlight. Dimensions of the whole ring system are given, showing that the outer condensations fall on the brightest part of the inner bright ring the outer one-fourth of which has previously been shown to be very much the brightest part of the entire system of Saturn. The inner condensations apparently fall on the crape ring. In reality the ring system is seen almost on edge, so that the visible surface is very oblique, and it seems possible that the inner bright ring may thus account for these condensations also. It was noticed that where the ring crossed the planet it did not produce any black trace, so this proves that the inner bright ring cannot be opaque to sunlight. As seen with the 40-in. Yerkes telescope, the full extent of the ring, viewed edge-on, appeared as a slender line of light on each side of the planet. Symmetrically on these, both preceding and following, were the condensations as two places of greater luminosity. The outer ones were elongated in the direction of the planet, and were approximately 0″·5 × 2″ in area. They were ill-defined and somewhat diffuse, and seemingly were thicker than the ring. Between these and the ball were the inner condensations, of equal brightness with the outer ones. All gave a pale nebulous light, and frequent comparisons showed that they were brighter than either of the satellites Mimas, Enceladus, or Tethys. Drawings are given showing the appearance presented by the condensations on 1907 Dec. 12 at 11h. 30m. G.M.T. C. P. B.

572. *Suspected New Ring to Saturn.* **R. Jarry-Desloges.** (Soc. Astronom. de France, Bull. p. 36, Jan., 1908. Nature, 77. p. 302, Jan. 30, 1908.)—Stationed at the Revard Observatory, Puy de Dome, at an altitude of 1,550 m., G. Fournier observed on Sept. 5, 1907, a faint transparent and luminous ring exterior to the principal rings of the planet. On Sept. 7 the same observer repeated the work, but neither he nor Jarry-Desloges could detect the new feature on Sept. 11. A drawing is given showing the luminous ring as it appeared on 1907 Sept. 7 22h. 25m. C. P. B.

573. *Belgian Observations of the Transit of Mercury, November* 14, 1907. **Lecointe.** (Comptes Rendus, 146. pp. 269–271, Feb. 10, 1908.)—The sky was nearly clear during the transit. A large number of observations of contact, and measures of diameter in various directions, by several observers, are given. Observations of position were also made, but the results are not quoted in the present note. Experiments were performed by Van Biesbrœck to test the influence of personality and irradiation on the measures of diameter. A sheet of ground glass was set up at a distance of 1,352 m. from the Observatory, and uniformly illuminated by electricity. In front of it was placed a black sphere of such size as to have the same diam. as Mercury when viewed with the equatorial. Thus the appearance was obtained of a black disc on a bright background. From his experiments and observation Van Biesbrœck deduces the value 9″·13, and Delvosal the value 9″·5, for the diam. of Mercury at the time of transit. The planet was only seen outside the sun's disc by one observer, after the passage, and his observation is recorded as very doubtful. The ligament, after second and before third contact, was seen by nearly all the observers. Merlin, at intervals, observed a yellowish aureole which diminished in intensity outwards. It persisted in all parts of the field, and resisted displacements of the eye. Delporte also reported an aureole, brownish-yellow at first, and light violet, nearly white, later ; but it was not perceived by his assistant. He also saw light spots, and at one moment a bright point near the place where a spot had been. The remark "illusion" is entered opposite this observation. Stuyvaert also reported bright spots and points and a line on the planet's disc. Bijl observed two sharp round black spots, one twice the size of the other, in the south-eastern portion of the planet. Generally speaking, Mercury appeared of a uniform tint, and darker than the nuclei of the sunspots. [See also Abstract No. 28 (1908).] A. E.

574. *Proper Motions of the Stars.* **K. Schwarzschild.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 5. pp. 614–632, 1907.)—Kapteyn has shown that the distribution of stellar proper motions may be explained by the hypothesis that the universe is divided into two great main star-streams moving in different directions and penetrating one another. Eddington, working by a different method, has obtained a confirmation of Kapteyn's hypothesis from examination of the material furnished by the new reduction of Groombridge's observations. The author, while fully recognising the remarkably satisfactory way in which Eddington's results represent the observed facts, nevertheless finds several reasons for regarding the principle of the duality of the Universe as inherently improbable. He has therefore subjected the material used by Eddington to a fresh investigation based on the assumption of the unity of the Universe. Eddington has expressly assumed that Maxwell's law of distribution of velocities prevails in each of the two supposed star-streams. The author replaces Maxwell's spherical distribution of the velocity vectors by an ellipsoidal one. If U, V, W denote the velocity-components of a star relative to a point regarded as at rest, then the number of velocities in the interval $U + \delta U$, $V + \delta V$, $W + \delta W$, according to Maxwell, is equal to $dUdVdW . e^{-(U^2 + V^2 + W^2)}$, A being a constant. For this expression the author substitutes $dUdVdW . e^{-AU^2 - BV^2 - CW^2}$, where A, B, C denote three different constants. The bulk of the investigation, being almost purely mathematical, is unsuitable for abstraction, but the following is a brief outline: The author first discusses the projection of his ellipsoidal velocity-distribution on the sphere, and then considers the effect of the sun's motion, and investigates the frequency of proper-motions in a given direction. He next discusses the results for the seven individual regions into which Eddington has divided the area covered by the Groombridge-Greenwich Catalogue, and gives a table showing the number of proper-motions for every 10°, together with the differences between his own figures and Eddington's. Finally he discusses the results for all the regions taken together, and arrives at the following verdict: "The distribution of the proper-motions of the Groombridge-Greenwich Catalogue, so far as yet examined, does not compel us to assume a division of the system of the stars into two different groups." On the contrary, the observed distribution can be satisfactorily explained on the hypothesis of the unity of the system, by making the following assumption: The frequency of a velocity of value between V and $V + dV$ in a given direction in space depends on the angle χ made by this direction with the direction of the vertex of the system, and is given by the formula $e^{-(1 - 0{\cdot}55\cos^2\chi)(V^2/V_0^2)} V^2 dV$, where V_0 is a constant. The vertex lies in the Milky Way, and its co-ordinates are R.A. = 273°, $\delta = -6°$. The motion of the sun relative to a point about which the velocities of the stars are grouped symmetrically is directed to the apex R.A. = 266°, $\delta = +33°$, and has the velocity $0{\cdot}70V_0$. A. E.

575. *β Lyræ as a Double Star.* **J. Stein.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 459–484, Feb. 20, 1908.)—An elaborate investigation of Pannekoek's light-curve for this Algol-type variable, with the object of ascertaining whether any important change in the elements of the orbits of the component stars has occurred since Argelander's time. To begin with, formulæ are derived suitable for deducing a slightly eccentric orbit from the variations of light. The formulæ are then applied to the light-curves of Argelander and Pannekoek, and also to Bélopolsky's spectroscopic data, which have been freshly reduced by the author. Different sets of elements, resulting from various assumptions, are discussed and compared. From an orbit based on Bélopolsky's spectrographs, provisional values for the masses are derived equal to 17·1 and 8·1 times the sun's mass, respectively, also values for the semi-axes major of 2,056,000 and 4,807,000 miles. The results of the investigation, in the author's opinion, justify the conclusion that the data are insufficient for a decision concerning any change in the elements, in particular the eccentricity. For the rest, where two gaseous bodies are in contact, as is probably the case in the present instance, the Keplerian equations can only give a rough approximation to the truth, while tidal action must contribute to mask the influence of the eccentricity on the course of the light-curve. All that can be inferred from the curves is that the orbit is nearly circular. A. E.

576. *New Researches on Variable Stars.* **C. Nordmann.** (Comptes Rendus, 146. pp. 518–521, March 9, 1908.)—The author has applied his new *photomètre hétérochrome* [see Abstract No. 590 (1908)] to the study of short-period variable stars of continuous variation. Hitherto the variations of such stars have been investigated only for the global light as a whole, but with his new apparatus the author is able to examine the light-curves for individual regions of the spectrum. The present note describes the results of his observations of β Lyræ and δ Cephei (periods 13 days and 5¼ days respectively). In the case of both stars he finds that the light-curve differs considerably both in amplitude and form according to the region of the spectrum examined, the amplitude of the blue curve being indeed about double that of the red. The epochs of maxima and of minima are the same for the different colours within the limits of precision attainable, but the measures are not capable of rendering perceptible an interval smaller than three or four hours for the stars in question. In the blue curve of β Lyræ the first maximum is much higher (0·3 mag.) than the second, while in the red curve the two maxima are about equal. The primary and secondary minima also are more unequal in the blue than in the red curve, or, in other words, the proportion of red rays emitted by β Lyræ is relatively greater at principal than at secondary minimum. The blue curve for δ Cephei has a point of inflection on its descending branch, which is not discernible in the red curve. β Lyræ and δ Cephei are believed to be binary or multiple systems, and the new data available may throw further light upon their physical constitution. The following are the numerical results :—

DIFFERENCES OF β-γ LYRÆ (IN STELLAR MAGNITUDES).

	Red Screen.	Green Screen.	Blue Screen.
At principal minimum	−0·70	−0·97	−1·36
At first maximum	[+0·04	+0·03	+0·02] ?
At secondary minimum	−0·45	−0·61	−0·68
At second maximum	0·00	−0·11	−0·26

[Either the + signs in this table, or the figures given in the original at the top of p. 520, appear to be erroneous.]

DIFFERENCES OF δ-ζ CEPHEI.

	Red Screen.	Green Screen.	Blue Screen.
At minimum	−1·07	−0·86	−0·99
At maximum	−0·40	−0·07	+0·17

A. E.

577. *Changes in Comet* 1907*d*. **E. Esclangon.** (Comptes Rendus, 146. pp. 17–20, Jan. 6, 1908.)—Observations made during Aug. and Sept., 1907, on Comet Daniel at the Observatory of Bordeaux with the great equatorial of 38 cm. aperture. The changes in the appearance of the head, envelopes, and tail are shown by several sketches. On the 4th of Aug. seven tails were easily discernible [Abstract No. 1621 (1907)], the central members being the longest. All were sensibly rectilinear with the exception of one, which showed a point of inflection at about 20′ of arc from the head. On the 12th of Aug. eleven tails were recorded photographically. On the 31st of July the angle between the extreme tails was about 36°; on the 16th of Aug. this angle was about 28°. C. P. B

578. *The Spectrum of the Aurora Borealis.* **W. M. Watts.** (Monthly Weather Rev. 35. pp. 405–412, Sept., 1907.)—The author briefly reviews the work of observers of the auroral spectrum, including Ångström, Vogel, Gyllenskiöld (Swedish Polar Expedition), Paulsen (Iceland), Sykora (Russo-Swedish Expedition, Spitzbergen), and others. The endeavour to reconcile the various observations forces him to the conclusion that the spectrum changes, especially the red portion. The same opinion has been expressed by Ångström and other authorities. Some auroræ are described as "red auroræ." In discussing the observations the author deals separately with (*a*) the chief auroral line in the greenish-yellow; (*b*) the lines in the red, which are only occasionally observed; and (*c*) the lines at the blue end of the spectrum, which seem to be related to the band spectrum of nitrogen, as seen in a Geissler tube. There seems little doubt that the characteristic green line is due to krypton, and there is considerable probability that the red line is due to neon, but the question arises why the other strong lines of krypton and neon are not also seen. Dewar has expressed the opinion that "the rosy tint in the streamers appears to be due to neon." The author is unable to arrive at satisfactory conclusions as to the origin of the other lines which have been recorded, and remarks that there is much doubt in the identification of a line as the same line in different observations. He has made experiments to discover what might be expected to be the effect of a conducting layer interposed at a certain height between the negatively electrified surface of the earth and the positively charged upper atmosphere. For this purpose a brass sphere 1½ in. in diameter was taken, and a glass tube, 12 in. long, into which the ball would just fit. The glass tube was converted into a vacuum tube and connected to a Fleuss pump; when exhausted to a pressure of 7 mm., with a kathode at the bottom, the tube gave the usual discharge, with the violet glow about the kathode, of which the spectrum showed the characteristic negative-pole spectrum of nitrogen. When the brass ball was inserted, supported by a short tube of glass at about 2/3 of the height of the large tube, it gave rise to a new kathode and anode spectrum within the tube. The behaviour of the discharge in the tube was observed whilst the pressure of the gas was varied. "At one particular pressure the band spectrum (of nitrogen) was seen in the upper and smaller compartment of the tube, whilst the lower compartment was not luminous. It would seem that at this pressure the electricity passed by conduction through the lower compartment sufficiently to produce luminosity by discharge in the upper one. It seems possible that the conducting stratum of condensed gases at a certain height above the earth may play the same part in the auroral discharge as the brass ball plays in the experiment described. There is difficulty in propounding any theory of the auroral discharge, which will apply both to auroræ observed at low elevations and also to those which have been observed at elevations of 400 or 500 km.; since at these extreme heights ordinary electrical discharges would be impossible." The author devotes a page or two to quotations from the recent literature of the subject, and concludes his article with an appeal to Americans to use their superior opportunities to obtain accurate observations of the spectrum of the aurora. For this purpose he suggests the use of a light wooden dark-room, revolving horizontally, so that a vertical slit in one wall can be opposed to the brightest part of the aurora, containing a large Thorp grating in front of a telescope of about 15 in. focal length, and a large lens, which need not be achromatic, to be placed outside the slit. Wratten and Wainwright's panchromatic plates are recommended. The photographs should be supplemented by observations with a binocular spectroscope furnished with large gratings. Measurements of wave-length can be made with the latter by aid of a nitrogen, or other, vacuum tube, placed so as to occupy a portion of the slit. A. E.

REFERENCES.

579. *Modified Short-fall Sprengel Vacuum Pump.* **J. A. Pollock.** (Roy. Soc. N.S. Wales, Journ. and Proc. 41. pp. 140–143, 1907.)—The raising of the mercury is effected by evaporating the mercury at a lower, and condensing it at a higher level. L. H. W.

580. *Photo-topography.* **C. W. Wright.** (Amer. Inst. Mining Engineers, Bull. 19. pp. 101–116, Jan., 1908.)—This paper describes the application of the panoramic camera to photo-topographic work. The photo-theodolite and other similar instruments are cumbersome and have many disadvantages which the panoramic camera has not. Full descriptions are given of this latter instrument and also of the method of use for obtaining maps from the photographs taken. A. W.

581. *New Length-measuring Instrument.* **C. Pulfrich.** (Zeitschr. Instrumentenk. 27. pp. 369–373, Dec., 1907. Communication from the Optical Workshops of C. Zeiss.)—The instrument is called the stereo-comparator. Rough readings are taken by eye alone to 1/10 mm. on a metal scale. Fine readings are taken on a glass scale to 1/100 mm. A series of mirrors are used to send the light on to the scale and then horizontally to the eye. The principle is also applied to the measurement of angles. P. E. S.

582. *Vector Algebra.* **W. Cramp** and **C. F. Smith.** (Elect. Engin. 41. pp. 399–401, March 20, 1908.)—The authors slightly modify Steinmetz's notation so as to discriminate between a unit vector in a particular direction and the operator denoted by *j*. They claim that the difficulty of products always present in the Steinmetz notation is completely eliminated. Numerical illustrations are given. A. R.

583. *Tension Tests of Steel Angles with various Types of End-connection.* **F. P. McKibben.** (Eng. News, 58. pp. 190–192, Aug. 22, 1907. Technology Quarterly, 20. pp. 479–488, Dec., 1907. Paper read before the Amer. Soc. for Testing Materials, Atlantic City, N.Y., June 22, 1907.)—The results of an experimental investigation are detailed.

584. *Disappearance of Saturn's Ring System.* **R. T. A. Innes.** (Roy. Astronom. Soc., Monthly Notices, 68. pp. 32–33, Nov., 1907.)—Observing with a 9-in. Grubb refractor, the disappearance of Saturn's rings was watched on Oct. 3, 1907, as the earth passed through the plane of the ring system. C. P. B.

LIGHT.

585. *Polarisation Photometer based on the Phenomenon of Scintillation.* **S. O. Majzel.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 39. No. 7. pp. 193–197, 1907.)—All scintillation photometers previously devised are inconvenient, owing to the too rapid succession of two images of unequal intensity from the two sources of light to be compared, this being the probable cause of the rapid fatigue of the observer's eye. In the author's photometer, on the intensity representing the sum of the two intensities to be compared, is superposed an intensity varying according to the sine law and having an amplitude equal to the difference of the two intensities. The diffused light from two planes illuminated by the respective sources of light is polarised by a Rochon prism, the ordinary light from one plane and the extraordinary from the other being then projected by a lens through a Nicol prism on to a diaphragm. When the Nicol prism is rotated with an angular velocity w, the intensity changes according to the law: $i = (I_1 + I_2)/4 + (I_2 - I_1) \cos 2wt/4$. A third plane, illuminated by one of the light-sources, may be introduced in such a way as to increase the accuracy of the instrument and at the same time to allow of it being converted into an invariable intensity photometer.

T. H. P.

586. *Quartz Compensating Polariscope with Adjustable Sensibility.* **F. Bates.** Bureau of Standards, Bull. 4. pp. 461–466, Jan., 1908.)—The instrument is of the double quartz wedge compensation type with a Lippich polarising system, employing white light. In this system the angle between the planes of polarisation in the two halves of the field is shown to be capable of a variation of about 10° without introducing an error due to a change in the zero point greater than 0°·1 S. (sugar degrees). The analysing nicol and the large polarising nicol are geared in such a way that the former always receives one-half the angular displacement of the latter. An instrument of the above kind has been made, and an illustration of it is given. G. E. A.

587. *New Spectrophotometer of the Hüfner Type.* **R. A. Houston.** (Phil. Mag. 15. pp. 282–287, Feb., 1908.)—Spectrophotometers are not usual in laboratories, partly owing to their cost and also to their construction, which usually prevents them from being used for any other purpose. In the present paper there is given a description of an attachment which may be fitted to any spectrometer or spectroscope, converting it into a spectrophotometer, and which may be removed at once when the ordinary use of the instrument is desired. A method for applying the instrument to the measurement of absorption in the ultra-violet is also described. J. J. S.

588. *Photographic Method of reproducing Bas-reliefs.* **A. Gradenwitz.** (Scientific American, 98. pp. 57–58, Jan. 25, 1908.)—Two photographs of the subject are made, the illumination of the latter being graduated in a special manner by the use of revolving discs; in the second photograph the direction of gradation of the lighting is reversed. A positive is made from one of the photographs and combined with the second, and when a bichromate gelatine plate is exposed below the combined plate the relief forms very rapidly. The method should become a valuable aid to the artist, and may further be used for reproducing work in an economical manner. It also enables the production of accurate plastic portraits. G. E. A.

589. *Variable Images with Diffraction Gratings.* **E. Estanave.** (Comptes Rendus, 146. pp. 391–392, Feb. 24, 1908.)—A screen of unpolished glass has a line grating fixed on each side of it, the gratings being at a small distance from the screen. Two different images are projected on the screen by means of two objectives, and the screen is covered by alternate strips of the two images. On looking at the screen from two particular positions on the opposite side, through the second grating, each of the images may be seen in turn; the line of the eyes is supposed to be sensibly parallel to the lines of the grating. G. E. A.

590. *Dispersion of Light in Interstellar Space.* **C. Nordmann.** (Comptes Rendus, 146. pp. 266–268, Feb. 10, and pp. 383–385, Feb. 24, 1908.)—The question whether luminous rays of all wave-lengths traverse interstellar space with exactly equal velocities has remained unsolved since Newton first proposed it to Flamsteed in 1691. [See, however, Abstract No. 1631 (1907).] The author has devised a simple apparatus for attempting a solution by a photometric study of monochromatic images of a short-period variable star. If the rays from the star have not the same velocity for different wave-lengths, it is evident that the minima of the different monochromatic images will not occur at the same epoch, but will be separated by time-intervals depending on the distance of the star. By means of a *photomètre hetero-chrome*, the author obtains a series of monochromatic images of the same star in the field of his telescope, measures their intensities in rapid alternation, and so deduces a series of contemporaneous light-curves corresponding to the various wave-lengths. The apparatus employed consists of an equatorial telescope furnished at the eye end with a photometer on Zöllner's principle, enabling the image of the real star to be compared with an artificial star the brightness of which is regulated by revolving two nicols with divided circles attached. Between the star images and the ocular is inserted a slide, moving at right angles to the axis of the telescope, and carrying three coloured screens, each screen transmitting only one-third of the visible spectrum. The first, or red, screen transmits wave-lengths from the extreme red to 0·59 μ; the second, or green, screen from 0·59 to 0·49 μ; and the third, or blue, screen from 0·49 μ to the extreme violet. The screens are formed of glass vessels containing coloured liquids of the following compositions:—

I. Red screen	Rouge de Hoechst No. 1	1 gm.
	Distilled water	500 „
III. Blue screen	Sulphate of copper crystals...	20 „
	Water and ammonia q.s.......	375 „
II. Green screen	Naphthal green ...	2·0 gm.
	Tartrazine	2·5 „
	Carmine blue	0·5 „
	Distilled water ...	6,250 „

The author finds that the probable error of a complete measure with his photometer is less than 0·04 stellar magnitude. In the case of Algol he deduces that his method is capable of rendering evident a difference of phase of 8 min. between the light-curves corresponding to the two ends of the visible spectrum. Assuming the distance of Algol to be 60 light-years, this would correspond to a difference of order 10^{-7} between the velocities of propagation in space of the ends of the spectrum (8 min. being contained about 10 million times in 60 years).

In the second paper the author describes the results of observations by the above method on the stars Algol and λ Tauri (which is of the Algol type) made in Paris, Switzerland, and Algeria. The following are the conclusions drawn: (1) The amplitude and form of the luminous variation are identical for all regions of the spectrum studied, in the case of both stars. (In the case of the continuously varying stars δ Cephei and β Lyræ, on the other hand, the amplitude and form of the light-curve were found to vary notably from one end of the spectrum to the other.) λ Tauri remains constant at minimum for over 8 hours. (2) The light-curves show an advance of the less refrangible rays, the phases of the red image being distinctly in advance of the phases of the blue image, while the phases of the green image occupy an intermediate position. (3) The observations lead to the following provisional numerical results: Rays from Algol of wave-length 0·68 μ appear to reach us about 16 min. in advance of rays of wave-length 0·43 μ, and about 9 min. in advance of rays of wave-length 0·51 μ. These values are subject to a probable error of ± 8 min. For λ Tauri the values of the displacements are about three times as great as for Algol. To sum up, all the results indicate that the luminous rays undergo in celestial space dispersion in the same direction as in ordinary refractive media. The author suggests that a comparison of the data obtained by his method with those furnished by ordinary parallax determinations, may throw light on the questions of the homogeneity of interstellar space, and the possible existence therein of dark nebulous masses. It is stated that Tikhoff is pursuing independent investigations at Pulkowa on the question of dispersion in space, and a comparison of results will be interesting. A. E.

591. *Dispersion of Light in Celestial Space.* **G. A. Tikhoff.** (Comptes Rendus, 146. pp. 570–574, March 16, 1908.)—The author starts with a brief review of various methods proposed since Newton's time for solving the problem, citing remarks by Cauchy, Arago, Rayleigh, and Förster. His own first attempts in 1898 were made by comparing the orbital phases and the light-phases of spectroscopic double stars which are also variable, such as δ Cephei and η Aquilæ. But evidence from other sources showed that the large displacements found could not be attributed to dispersion, but must have their origin in the nature of the stars. During a stay at Meudon in 1898–99, he made experiments on the spectrophotometry of variable stars by visual methods, still with the hope of throwing light on the dispersion problem, but found that the methods of ordinary prismatic analysis involved too great practical difficulties. In 1903, however, Bélopolsky succeeded in applying a spectral method of studying dispersion to the star β Aurigæ. The author assisted in examining the spectra obtained, and confirmed Bélopolsky's result that the indigo orbit was in advance of the violet orbit [see Astronom. Jahrbuch, 1905 and 1906, for *résumé;* the original papers are in Russian]. On resuming his experiments on variable stars at Pulkowa in 1906 the author employed photography, and adopted the use of coloured gelatine filters for isolating the various regions of the spectrum. A graduated series of 8 such screens was prepared, through which the stars RT Persei (Algol type) and W Ursæ were observed. The following is a brief statement of the results obtained by the method of degrees [the full account will appear in No. 21, *Mitteilungen*, Pulkowa Observatory]: RT Persei (period 20h. 28m. 10s.). Studied in the rays of 560 μμ and 430 μμ. 84 comparison stars. Duration of variation, 8 hours and 2 hours. The minimum of the 560 μμ curve is in advance on the other by 4 min. W Ursæ (period, 4h. 0m. 18·2s.). Studied in the rays of 625 $\mu\mu$ (orange), 490 $\mu\mu$ (blue-green), and 380 $\mu\mu$ (ultra-violet). 18 comparison stars. The orange and ultra-violet curves are much alike. The blue-green curve is less certain, and shows a double minimum. The orange minimum is in advance on the ultra-violet minimum by 10 min. A great diversity was found in the colours of the comparison stars. Thus the results obtained by Bélopolsky, Nordmann [see preceding Abstract], and the author all confirm one another in testifying to a greater retardation for the rays of shorter wave-length. In the author's method, as in Nordmann's, it is a question of observing groups of waves in the sense indicated by Rayleigh (Theory of Sound, Vol. I., No. 191, and Appendix) and Gouy. Denoting the velocity of the group of waves by U, and that of individual waves by V, we have $U = (V - \lambda)dV/d\lambda$. Assuming for interstellar space the law of dispersion $V_0/V = A + B/\lambda^2$, we obtain the relation $dU = 3dV$, neglecting small quantities of the second order. Hence, if the displacements found are due to dispersion, they are three times greater than those calculated with the refractive indices giving V. The observed displacements must therefore be divided by 3 in order to obtain the dispersion in the ordinary sense, that is, the dispersion of individual waves. If dispersion in space followed the law $V = a + b\lambda$, we should have $U = a$, and such dispersion would escape detection by the adopted methods. The author remarks that certain observations lend countenance to the supposition that in space there may occur a selective absorption of light, increasing with galactic latitude, and with diminishing wave-length (Kapteyn, Bull. de la Carte du Ciel, II., p. 181). It is also possible that the dispersion may be different in different galactic latitudes. He regards the first results as encouraging, and considers that in the case of some variable stars the times of the phases may be approximated to within some tens of seconds of time. A. E.

592. *The Brocken Spectre.* **F. Richarz.** (Meteorolog. Zeitschr. 25. pp. 19–25, Jan., 1908. Physikal. Inst. d. Univ., Marburg, Aug., 1907.)—The Brocken spectre is the shadow of the observer on a bank of fog more or less distant from himself. The spectral character is produced by the difficulty in estimating the distance of the shadow, which therefore tends to appear as of enormous dimensions. An "artificial" Brocken spectre is seen when the lamp (preferably an arc lamp) in a room illuminates the fog outside, and the observer casts his own shadow on the fog. Seen with the right eye only, the spectre appears sharply defined on the right only, and *vice versâ.* This is due to the fact that a terminating surface of the shadow passes nearly through the eye of the observer, and is seen end-on by the eye on that side of his face. Parallel rays from the sun produce practically a divergent beam owing to the finite size of the sun's disc. The author reduces the halo round the shadow of the head to a subjective effect analogous to Mach's fringes, which appear wherever the illumination curve has a bend. The coloured diffraction fringes are produced by reflection from the front surface of the droplets, together with lateral absorption (cf. Lambert's law) which produces a maximum intensity in the direction of incidence. E. E. F.

593. *The Mirage.* **A. Garbasso.** (N. Cimento, 14. pp. 411–420, Nov., 1907. Paper read before the Soc. Ital. di Fisica, at Parma.)—The general explanation of the phenomena known as mirage is that they depend on a certain inhomogeneity of the atmosphere, due to variations of temperature

and of hydrometric condition. The phenomenon has various forms, distinguished by the writer in three categories, as the mirage of Monge, of Vince, and of Parnell, characterised respectively by one, two, or four secondary images. He takes as foundation of his theory Fermat's principle that "given two isotropic and homogeneous media separated by a plane, and two points, one on either side of the plane, then of all routes by which light can pass from one point to the other, the shortest time route, or brachistochrone, will be the one chosen." The principle has been extended by Helmholtz to more than two media, and it is possible to proceed to the limiting case of an isotropic and continuously varying medium. The author defines his linear element of space by two classes of co-ordinates, and obtains the Lagrangian and the Hamiltonian equations for the propagation of light. An example is given, founded on the method of diffusion suggested by Wollaston. A solution of zinc chloride in gelatine, of uniform strength, is contained in a vessel, and water is caused to circulate continuously on the free surface, so that diffusion takes place. When this has gone on for some hours an object outside of the vessel presents the two images of Monge's mirage. Analytically he applies to the index of refraction n, Fourier's equation $dn/dt = \kappa^2 \Delta n$, where κ is constant. Hence he obtains the result that, in two dimensions, a given point x, y is connected with the origin by two possible trajectories, or none, or one, according as the point is within, or beyond, or upon the parabola $4n_0^4 + 4n_0^2 ax - a^2y^2 = 0$. He also determines the wave surface in this case. In another experiment due to Rolla, a prismatic vessel contains a layer of carbon disulphide, and above it a homogeneous mixture of alcohol and chloroform. After some hours there are observed five images of an object outside of the vessel, alternately direct and inverted. These are the five images of Parnell's mirage. S. H. B.

594. *Optics of Turbid Media.* **G. Mie.** (Ann. d. Physik, 25. 3. pp. 377–445, March 3, 1908. Physikal. Inst., Greifswald.)—Deals with turbid media on the assumption that the particles may be regarded as spherical, and that the turbidity is infinitely thin in the optical sense. The latter condition is fulfilled in ordinary colloid solutions. The light emitted by the small particles may be calculated as a series of partial waves. There are two groups of these, corresponding respectively to the electric and magnetic vibrations of the particles. In colloid solutions with very fine particles only the first electrical term, which corresponds to Rayleigh's radiation, has a perceptible value. With coarser particles the second electric and the first magnetic vibration also come into play. The assumption of a perfect conductivity of the spheres leads to different results, and must be abandoned. If an unpolarised ray traverses the turbid liquid the light emitted laterally is linearly polarised, partially or entirely, but is never elliptically polarised. Up to a size of $0{\cdot}1\mu$ the light diffused by gold particles laterally consists almost entirely of Rayleigh's radiation, which has a maximum (100 per cent.) at 90°. When the particles become larger the amount of light unpolarised at 90° rapidly increases, and the maximum of polarisation moves forward. For particles from $0{\cdot}16$ to $0{\cdot}18\mu$ it lies between 110° and 120°. At the same time the mutual interference of the partial waves disturbs the original symmetry of Rayleigh's radiation, and another argument against the perfect conductivity of the spherules is obtained. At constant concentrations the diffused radiation of very fine turbidities is proportional to the volume of the individual particle. But as the particles increase it tends towards a maximum, which it reaches at a diam. of $\lambda/8$ or $\lambda/4$. The colour of light diffused from very fine particles is bluish-violet, and from coarser ones white. No explanation, by resonance or otherwise, is yet obtained as regards the vivid colours of some colloid solutions. Gold particles diffuse more light than would be diffused by equal perfectly-conducting particles. The colour of colloid gold is explained by the maximum absorption in the green and the maximum reflection in the orange. Very small particles absorb much and reflect little, and the solution is therefore ruby-red. E. E. F.

595. *Photographic Reversal with Röntgen Rays.* **M. Chanoz.** (Comptes Rendus, 146. pp. 172–174, Jan. 27, 1908.)—Describes an effect similar to that due to over-exposure of very bright objects, such as the sun. A sensitive plate is partly covered with a steel watch-spring 0·12 mm. thick and wrapped in black paper. It is then exposed to Röntgen rays for 2 hours, a lead screen being gradually drawn across it so as to expose different portions of the plate for different lengths of time. The density of the developed plate is not simply proportional to the exposure. It is subject to variations. The most remarkable of these is the blackening produced under the watch-spring. With an exposure under 2 min. the covered patch is more transparent than the rest of the plate. After further exposure it becomes equal, and after about 10 min. the patch under the steel is denser than the rest. On further exposure the two areas again become equal, and when the exposure has reached 1¼ or 2 hours the covered portion is again less dense than the uncovered portion. This is in strict parallelism to the photography of the sun and the adjoining sky. E. E. F.

596. *Primary Standard of Light.* **C. P. Steinmetz.** (Amer. Inst. Elect. Engin., Proc. 27. pp. 297–302, March, 1908.)—The physiological effect of a source of light cannot be measured in absolute physical units; it is expressed by comparing it with an arbitrarily chosen standard. Flame standards are affected by numerous errors. It is advisable therefore to have a standard which can be tested by energy measurements. The definition of the absolute unit of light as the physiological effect of one watt of power of visible radiation is not definite unless we also define how the power is distributed amongst the different luminous waves. Such a distribution of power might be specified, for instance, by fixing on the black-body radiation at a definite temperature. For example, we might say that the unit of light is that given by a black body radiating one watt of power between the wave-length of 39 and 72, at the temperature where the power of radiation from wave-length 39 to 55 bears to that from 55 to 72 a specified ratio. The author points out that this standard would not be ideal because the physiological effect of the intensities of radiation of different wave-lengths is neglected. In addition, the absorption constant of glass varies with the wave-length, any deviation from black-body radiation vitiates the result, and the colour of the light would be yellow owing to the temperature limitation. The author considers that a better standard of light could be based on measurements of the radiating power in three primary colours of the visible spectrum, provided these colours are of definite wave-length, equally spaced on the spectrum and capable of being reproduced at high intensity as the spectrum lines of a luminous gas or vapour. The unit of light could now be defined as that given by a power of one watt radiated at these three wave-lengths in definite proportions chosen so as to give white or yellowish-white light. That is, the primary unit of light would be the physiological effect, as observed on the white

photometer screen of a power of one watt radiated in the three definite wave-lengths A, B, and C in specified proportions. As the mercury vapour lamp emits three monochromatic radiations it would be a suitable standard. When protected from air draughts and the current maintained constant the radiation is remarkably constant. If the current varies, the radiation only varies as the first power of the current. As a mercury lamp is merely a source of monochromatic light it is not necessary to make standard mercury lamps have the same intensity. The author recommends, therefore, that mercury lamps should be chosen as the sources from which to obtain the three monochromatic radiations. He suggests that the blue (43·55), the green (54·6), and the red (69·1) be chosen, as they are nearly equally spaced on the spectrum. Two low-temperature mercury lamps would be required for the blue and the green, and one high-temperature quartz lamp for the red. By means of a prism the blue line of the first, the green of the second, and the red of the third are thrown on the same white screen, and their radiation energies can be measured separately. The best relative proportions of the colours should be investigated. A yellowish-white would probably be most convenient in practice. Such a selection of three primary colours would also enable the colour of any source to be expressed as a ratio of the three intensities of the standard rays required to reproduce a light identical in colour with that being measured. A. R.

597. *Anomalous Rotatory Dispersion of Neodymium.* **R. W. Wood.** (Phil. Mag. 15. pp. 270–274, Feb., 1908. Phys. Zeitschr. 9. pp. 148–151, March 1, 1908.)—A solid, amorphous, and isotropic film of neodymium nitrate, mounted between thin cover-glasses, and 0·1 to 0·5 mm. thick, was mounted between the poles of a large magnet, and transmitted light was extinguished by crossed nicols. On exciting the magnet the light was restored all over the spectrum, but more especially near the absorption band. When the analysing nicol was turned in the direction in which the plane of polarisation had rotated, a dark band entered the violet end of the spectrum and moved towards the red, this motion being the reverse of that ordinarily observed. This means that in neodymium the rotation decreases as the wave-length decreases. The magnetic spectrum is very peculiar. If the analysing nicol is turned a degree or two in the direction in which the rotation has occurred, the bright band at λ5790 moves distinctly towards the blue, while rotating the nicol in the opposite direction causes a motion towards the red. The author bases an explanation upon the existence of absorption bands which may conspire for wave-lengths on the blue side and oppose each other for the longer waves on the red side. E. E. F.

598. *Existence of Positive Electrons in the Sodium Atom.* **R. W. Wood.** (Phil. Mag. 15. pp. 274–279, Feb., 1908. Phys. Zeitschr. 9. pp. 124–127, Feb. 15, 1908.)—Some of the spectrum lines of sodium give a magnetic rotation opposite to that of the D-lines, and this suggests, at least, the possibility of the existence of positive electrons. Sodium vapour has in this respect a distinct advantage over the tysonite absorption bands studied by J. Becquerel, which are produced by molecules of rare earths in combination with or embedded in other substances. In the vicinity of the D-lines of sodium, the rotation is easily determined by a slight rotation of the analysing nicol, which moves the broad bands of rotated light bordering the absorption lines from side to side. In the case of the narrow lines of the channelled spectra, no information can be gathered as to whether the rotation is positive

or negative by rotating the analysing nicol, for the smallest possible turn from the position of extinction causes the continuous spectrum to brighten up, obliterating the rotation lines. The difficulty lay in finding lines of just the right wave-length. The author eventually used the selective rotatory power of the vapour itself as a light-filter. The light passed by the crossed nicols when the magnetic field was excited was sent through another magnetised tube of vapour and examined with a third nicol spectroscope. A pair of very thin Fresnel quartz-prisms was used to obtain a single dark band along the length of the spectrum. With this arrangement the magnetically rotated line should penetrate the dark band from above or below, according as the rotation is positive or negative. In the neighbourhood of the D-lines short needles of light shoot down from the continuous spectrum above into the dark region immediately to the right and left of the D-lines, indicating that they are caused by vibrations of negative electrons. The sodium tube was heated until the fine black absorption lines in the red appeared distinctly in the continuous spectrum above and below the dark band. On exciting the magnet, numerous needles of light commenced to penetrate the dark region, some of them shooting down from above, others shooting up from below. Of these, some only extended half-way or less across the dark band, others crossed it completely. This suggests the existence of both positive and negative carriers in the atom. These observations were made in the orange. The author is now studying the effect in the green and blue.

E. E. F.

599. *The Echelon Spectroscope.* **H. Stansfield.** (Nature, 77. p. 198, Jan. 2, and p. 222, Jan. 9, 1908.)—In examining the green mercury radiation from an Arons lamp, it was noticed that a rotation of the echelon round a vertical axis causes a series of black lines to travel across the image of the principal green line. These secondary bands are due to faint spectra of a very much higher order than the primary spectra. Such spectra must be formed by a series of beams that have suffered two reflections at the external surfaces of the echelon. Each of these secondary beams has traversed the echelon three times, and the retardations form a series the common difference of which is seven times that for the beams giving the primary spectra, assuming $\mu = 1{\cdot}5$. It is found, further, that the reflections at the interfaces of the echelon materially assist in the forming of the secondary spectra. If the echelon be built up one plate at a time, starting with the largest, each plate starts a series of secondary beams and adds another term to each of the series started by the earlier plates. The retardations in each series have the same seven-fold common difference, and all help in forming the secondary spectra. Each member of the series started by the *n*th plate has *n* times the intensity of the unit secondary beam produced from the primary beam by two interface reflections, consequently the last few steps of the echelon are much more effective, and the clearness of the secondary spectra may be much improved by covering over the first half of the whole number of steps built up.

E. C. C. B.

600. *Gradual Modification of the First Linear Emission Spectra of Mercury.* **E. Castelli.** (Phil. Mag. 14. pp. 784–785, Dec., 1907. N. Cimento, 15. pp. 57–62, Jan., 1908.)—The lines of the spectrum of the electric arc in mercury vapour in a Uviol lamp undergo a gradual change in their photochemical action, although their positions remain unchanged. The action of the lines corresponding with less refrangible monochromatic rays becomes more

intense, whilst with the more refrangible lines the contrary occurs. In a spectrophotograph recently made it was found that the three lines of the wave-lengths, 3663·3, 3654·9, and 3650·3 Å.U. had almost completely vanished, whilst the lines 5790·49, 5769·45, and 5460·97, which in the first experiments gave a scarcely visible photographic impression, produced much clearer and more intense impressions than any other line. These changes are attributed to an alteration in the character of the positive monovalent ions, probably consisting in such a variation of the vibrating mass that oscillations of a higher frequency are rendered impossible, whilst the vibrations of shorter wave-length, due to a state of smaller capacity for motion, are made easier, and are therefore intensified. T. H. P.

601. *The Intensity of Spectrum Lines.* **A. D. Cowper.** (Nature, 77. p. 248, Jan. 16, 1908.)—From a series of experiments with electrodeless vacuum tubes and a slowly oscillating current the optical intensity of the spectrum lines when the discharge is viewed end-on is found to be accurately proportional to the readings of a thermo-galvanometer placed in series. Furthermore, the optical intensity with a constant current is inversely proportional to the pressure of the gas, though these latter experiments extended over a more limited range. The intensity is therefore proportional to $\lambda\int c^2 dt$, where λ is the mean free path. E. C. C. B.

602. *Infra-red Emission Spectra.* **W. W. Coblentz.** (Phys. Zeitschr. 9. pp. 60–64, Jan. 15, 1908. From the English.)—I. *Emission spectra of metals in hydrogen.* In a previous paper the author has recorded that in his investigations on arc spectra only the alkali metals appeared to have strong emission lines in the infra-red. With such metals as copper, iron, and zinc there appeared a weak continuous spectrum in the region from 2 up to 3 μ. This appeared to proceed from the hot oxide, and therefore it might be expected to disappear if the arc was produced in an atmosphere of hydrogen. The results of investigations on this point are given. (*a*) *Nickel arc in hydrogen.* Observations were made upon the nickel arc in hydrogen. The spectrum in the red where the chief radiation was observed appeared continuous. At 0·75 μ a strong emission was noticed. Beyond 2 μ the radiation from the hot electrodes is indicated by the quick rise of the radiation curve. The results show on the whole only a small radiation in the neighbourhood of 2 μ where formerly a continuous spectrum was observed. Moreover, at 1 μ where the alkali metals possess intense lines no strong emission lines appear. (*b*) *Spark spectra of metals in hydrogen.* Investigations were made upon aluminium, copper, and calcium. The result appeared to be that no emission lines which possessed marked intensity were produced. This is somewhat surprising, as calcium is near the group of those elements which possess emission lines in the infra-red. II. *The emission spectrum of the carbon arc* was next investigated. With a current strength of from 5 to 15 amps. an emission band at 4·5 μ appeared if salts of the alkali metals were present in the arc, whilst the pure carbon (with 15 amps. current) exhibits a small selective emission in this region. The author discusses the results of the investigations made by Paschen and Moll. J. J. S.

603. *Analysis of the Oxides of Nitrogen by means of their Absorption Spectra in the Infra-Red.* **E. Warburg** and **G. Leithäuser.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 6. pp. 148–153, 1908. Communication from the Physikal.-

Techn. Reichsanstalt.)—Measurements were made by means of the vacuum bolometer [see Abstract No. 2099 (1907)] of the absorption spectra of O_3, N_2O_5, N_2O_4, NO_2, NO, and N_2O between the limits of 2·7 and 7 μ. The absorption curves are tabulated in the paper, and the results are shown to be applicable to the quantitative estimation of each and all of the above gases in any mixture of them. For example, the constitution of the mixture produced by the passage of various discharges through pure dry air was determined. In the case of the silent discharge in a Siemens ozoniser, it was found that, in addition to ozone, N_2O_5, N_2O, and Hautefeuille and Chappuis' new oxide are produced. When the discharge from an electrical machine is passed between platinum electrodes, only NO_2 and N_2O are formed. When a high-tension alternating arc between platinum poles is passed through the air, only NO_2 and N_2O_4 are produced. The relative quantities are given in the paper.

E. C. C. B.

604. *Absorption Spectrum of Ruby.* **A. Miethe.** (Deutsch. Phys. Gesell., Verh. 9. 23. pp. 715–717, Dec. 15, 1907.)—The wide absorption band of ruby in the green and yellow is accompanied by a number of fine absorption lines hitherto not catalogued. These are at 6960 and 6940, and in addition, there are narrow bands at 6690, 6600, 4760, 4750, and 4670. The lines first named are the sharpest yet found in solids or liquids. They strictly correspond to the fluorescence lines in the red which produce the characteristic red colour of the ruby. The wave-lengths which produce the fluorescence lie between 3900 and 3800. Kathode rays also produce vivid fluorescence. E. E. F.

605. *Spectra of the Alkali Metals.* **C. Runge.** (Phys. Zeitschr. 9. pp. 1–2, Jan. 1, 1908.)—Referring to the discovery by Bergmann of a new spectral series of lines in the infra-red region of K, Rb, and Cs, the author points out a certain relation between this series and the two subordinate series. The differences between the convergence frequency of the new series and those of the two secondary series come close to the frequencies of the first pair of the first subordinate series. The author doubts Bergmann's observation that the pairs of the new series in Cs possess constant frequency-difference; he thinks it more probable that the pairs have a common convergence-frequency.

E. C. C. B.

606. *The Arc Spectrum of Cerium.* **A. Bakowski.** (Zeitschr. wiss. Phot. 6. 3. pp. 73–100, 1908.)—A measurement of the lines of the arc spectrum of Ce from $\lambda = 5003{\cdot}605$ to $\lambda = 2576{\cdot}191$. The wave-lengths were determined by comparison with the iron spectrum with a concave grating; Kayser's standard wave-lengths were employed up to $\lambda = 4469{\cdot}566$, and for longer wave-lengths those of Rowland. E. C. C. B.

607. *Separation and Quantitative Spectra of Cerium, Lanthanum, and Yttrium.* **J. H. Pollok** and **A. G. G. Leonard.** (Roy. Dublin Soc., Proc. 11. 23. pp. 257–269, Feb., 1908.)—The first part of the paper is concerned with the preparation of pure oxides of Ce, La, Di, and Y from cerite, while the second part contains their quantitative spectra as obtained with gold electrodes and described in previous papers. It was found that it was not possible to observe the quantitative spectra of Di, as they disappear so rapidly on dilution [see Abstract No. 1509 (1907)]. E. C. C. B.

608. *Quantitative Spectra of Molybdenum, Tungsten, Thorium, and Zirconium.* **A. G. G. Leonard.** (Roy. Dublin Soc., Proc. 11. 24. pp. 270–279, Feb., 1908.)—This paper deals with the quantitative spectra of ammonium molybdate, sodium tungstate, thorium nitrate, and zirconium chloride. Attention is drawn to the fact that in all the quantitative spectra as yet published the most persistent lines tend towards the more refrangible part of the spectrum, which means that these lines represent the wave-lengths of those vibrations which are most easily excited within the molecule. This affords an explanation why the ultra-violet rays are more chemically active than those of less refrangibility, for they can more readily set the atoms or molecules into vibration, and so induce chemical action. E. C. C. B.

609. *The Swan Spectrum.* **K. v. Wesendonk.** (Phys. Zeitschr. 9. pp. 151–154, March 1, 1908.)—The author discusses at some length the various views held as to the origin of the Swan spectrum. He, however, describes some experiments in which chlorine is fed into a coal-gas flame burning in air, when the Swan bands are intensified to a marked degree. He concludes that the Swan spectrum is without doubt due to a hydrocarbon. E. C. C. B.

610. *An Exceptional Case of the Zeeman-effect.* **A. Dufour.** (Comptes Rendus, 146. pp. 118–120, Jan. 20, 1908.)—Abnormal effects are recorded in the magnetic resolution of the bands in the flame spectrum of CaF_2. The spectrum shows four groups of bands, with heads at $\lambda = 6064{\cdot}49$, 6050·81, 6036·96, and 5840. When the band with head at 6036·96 is observed along the lines of force the two components in a field of 10,000 gauss are separated by about 0·3 Å.U., but their circular polarisation, though not complete, is in the opposite sense to the usual, and corresponds to that of vibrating positive electrons. A similar result—though the observations were more difficult—is obtained in the case of the bands with heads at 6050·81 and 5840. [See also next two Abstracts.] E. C. C. B.

611. *Emission Spectra of Fluorite.* **H. Becquerel.** (Comptes Rendus, 146. pp. 153–156, Jan. 27, 1908.)—In reference to Dufour's observation of the abnormal Zeeman-effect with the flame spectrum of pure CaF_2 [see preceding Abstract], the author attributes the bands which present the abnormality to rare earth impurities, since such abnormalities are observed in the case of the didymium and erbium absorption bands. This conclusion is borne out by observations on the spectra of fluorite, which shows certain rare-earth bands, attributed by Urbain to terbium, samarium, and dysprosium. [See also next Abstract.] E. C. C. B.

612. *Variations in the Absorption Bands of Didymium and Erbium Salts in the Magnetic Field.* **J. Becquerel.** (Comptes Rendus, 145. pp. 1412–1415, Dec. 30, 1907. Chem. News, 97. pp. 49–50, Jan. 31, 1908.)—The author has succeeded in studying the Zeeman-effect in the case of didymium and erbium salts by cooling down solutions or suspensions of them in alcohol or mixtures of alcohol and water by means of liquid air. By this means the bands were obtained sufficiently narrow and well-defined for the purpose. Though the resolution is of the same order in each case, the bands due to the circular vibrations of the same sign are not always displaced to the same side. The

author feels that it is premature to speak categorically on the existence of positive electrons, although his results would seem to support this view. [See also Abstracts Nos. 610 and 611 (1908).] E. C. C. B.

613. *Anomalous Modifications in the Magnetic Field of the Band Spectra of various Compounds.* **A. Dufour.** (Comptes Rendus, 146. pp. 229–231, Feb. 3, 1908.)—It was pointed out in a previous paper [Abstract No. 610 (1908)] that some of the bands of CaF_2, when viewed in a magnetic field parallel to the lines of force, showed circular polarisation in a sense corresponding to the existence of positive electrons. H. Becquerel pointed out that the bands which showed these anomalies were probably due to impurities, but in the present paper the author describes exactly the same anomalous behaviour with bands in the spectra of SrF_2, BaF_2, $CaCl_2$, $SrCl_2$, and $BaCl_2$. He points out that this is strongly against the suggestion of impurities, and considers that these bands are doubtless due to the undissociated molecules of the halogen compounds. He suggests that the new phenomena are probably due to the fact that spectra of compounds are in question, all previous work being mainly on elementary spectra. [See Abstracts Nos. 611 and 612 (1908).] E. C. C. B.

614. *Spectra of Undissociated Compounds.* **H. Becquerel.** (Comptes Rendus, 146. pp. 257–259, Feb. 10, 1908.)—Referring to Dufour's experiments on the behaviour of the bands in the spectra of the halides of the alkaline earth metals in the magnetic field [see preceding Abstract], the author points out that the results are not new, and that they confirm the close resemblance previously pointed out between these and phosphorescent and absorption spectra. E. C. C. B.

615. *The Zeeman-effect.* **W. Lohmann.** (Zeitschr. wiss. Phot. 6. pp. 1–24, Jan., and pp. 41–60, Feb., 1908. From Inaug.-Dissertation, Halle.)—An accurate investigation into the magnetic resolution of the lines of helium and neon, and also some of the lines of Na and Hg. An echelon grating was used, and various magnetic fields up to 18,000 gauss. Full details of the measurements are given in the paper, together with reproductions of the photographs. It is interesting to note that the type of resolution is far more complex in the case of neon than in the case of helium. E. C. C. B.

616. *Magnetic Resolution of the Spectrum Lines of Barium, Yttrium, Zirconium, and Osmium.* **B. E. Moore.** (Ann. d. Physik, 25. 2. pp. 309–345, Feb. 7, 1908. Extract from Inaug.-Dissertation Göttingen.)—A complete study of the Zeeman-effect as observed in the case of Ba, Y, Zr and Os. The measurements are given in full in the paper. It was found impossible to detect any evidence of series lines in the case of the last three elements. A great number of new types of resolution were noted with Y and Zr. E. C. C. B.

617. *The Zeeman-effect in Helium.* **W. Lohmann.** (Phys. Zeitschr. 9. pp. 145–148, March 1, 1908. Physikal. Inst., Halle.)—An investigation of the Zeeman-effect with helium, using an echelon grating ($\lambda/d\lambda$ for $D_1=345000$) and magnetic fields from 7,874 to 12,170 gauss. Each of the helium lines is resolved into a normal triplet, the separation of which is the same for all, and when expressed as $d\lambda/\lambda^2$, is directly proportional to the strength of

the field. Further, the two satellites of the line $\lambda = 5876$ are each resolved into two triplets which have the same separation as the normal triplets. These results show that the helium atom must be the simplest of all the known elements. E. C. C. B.

618. *The Fluorescence and Absorption of Anthracene.* **L. S. McDowell.** (Phys. Rev. 26. pp. 155–168, Feb., 1908.)—The author has observed the fluorescence and absorption spectra of commercial and pure anthracene in the solid and gaseous states, and also in solution in various solvents. He finds that the commercial material, containing chrysogen, in the solid form exhibits fluorescence bands at $\lambda = 4980$ and 5300 and absorption bands at $\lambda = 4990$, 4870, and 4620–4520, and continuous absorption beyond $\lambda = 4215$. Pure solid anthracene shows fluorescence bands at $\lambda = 4250$, 4500, and 4700; in solution it shows bands at $\lambda = 4050$, 4275, 4750, and (?) 4820. The fluorescence bands shift towards the shorter wave-lengths with the change from solid to solution, and from solution to vapour. The absorption of pure solid anthracene is continuous beyond $\lambda = 4100$, and beyond $\lambda = 4050$ for the same in solution. E. C. C. B.

619. *Phosphorescence at Low Temperatures.* **J. de Kowalski.** (Comptes Rendus, 145. pp. 1270–1272, Dec. 16, 1907.)—After exposure to ultra-violet light from a mercury arc lamp at the temperature of liquid air, alcoholic solutions of the nitrates of the rare earths exhibit vivid phosphorescence, the colour of which varies with the nature of the rare earth; the phosphorescence lasts for about 5 min. after the action of the light ceases. Alcoholic solutions of phenanthrene, anthracene, and anthraquinone also exhibit strong phosphorescence under the above conditions, the intensity depending on the concentration of the solution; with anthraquinone and anthracene the phosphorescence diminishes gradually with diminution of concentration, whilst with phenanthrene it exhibits an optimum with a 0·2 per cent. solution. T. H. P.

620. *Nature of the Phosphorescent Elements and Meta-elements of W. Crookes.* **G. Urbain.** (Comptes Rendus, 145. pp. 1335–1337, Dec. 23, 1907.)—According to the author's observations, the assumption that the phosphorescent rare earths are mixtures of elements is unnecessary for explaining variations of the phosphorescence. It is only necessary to mix terbium and gadolinium in varying proportions, in order to cause the bands corresponding with these hypothetical constituents—G_α, G_δ, G_ζ, ionium and incognitum—to appear or disappear; mixtures containing less than 0·5 or more than 10 per cent. of terbium are very slightly phosphorescent. T. H. P.

621. *Phosphorescence produced by Canal Rays.* **J. Trowbridge.** (Amer. Journ. Sci. 25. pp. 141–142, Feb., 1908.)—J. J. Thomson has found that when a layer of lithium chloride is bombarded with canal rays it shines with a bright red light, and the lines of the lithium spectrum are very bright. When the salt is subjected to kathode rays its colour is steely blue; it gives a faint continuous spectrum but not the lithium lines. It is now found that the red colour can also be produced by kathode rays. The rays from a concave kathode are shot through a hole in the anode and down a cylindrical tube, on the bottom of which is the lithium chloride. The cylindrical

tube is surrounded by a solenoid, and the magnetic field due to this focuses the rays on to a small area. This area appears red in the centre and blue at the edges. It appears, therefore, that the production of the two colours is a question of energy on unit area. [See also Abstract No. 486 (1908).]
R. S. W.

622. *Wave-length of Röntgen Rays.* **W. Wien.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 5. pp. 598–601, 1907.)—The great speed of secondary kathode rays has been shown by the author to be probably an explosive speed, due to intra-atomic energy. According to an extension of Planck's theory of radiation, the elementary quantity of energy is the quantity which is required to drive an electron out of the atom, or is liberated in the form of radiation when an electron is absorbed by an atom. This element of energy, by Planck's law, is $\epsilon = hc/\lambda$, where h is the radiation constant, c the velocity of light, and λ the wave-length. Knowing the mass and speed of electrons constituting secondary rays, their energy is known, and since that of a single electron equals the elementary quantity, we have sufficient data for determining the wave-length of the Röntgen pulse. This comes out as $6{\cdot}75 \times 10^{-9}$ cm., which agrees fairly well with the diffraction value of Haga, Wind, and Sommerfeld, viz., $1{\cdot}3 \times 10^{-8}$. E. E. F.

623. *Nature of Röntgen Rays.* **C. G. Barkla.** (Nature, 77. pp. 319–320, Feb. 6, 1908.)—A rejoinder to Bragg concerning the electric-doublet theory of the latter [see Abstracts Nos. 58, 412 (1908)]. The author contends that his assumptions made in an earlier letter are not so unjustifiable as Bragg supposes. He points out that, after measuring the intensity of the secondary radiation proceeding in a direction perpendicular to that of propagation of the primary beam, from a substance of low atomic weight during the transmission of soft Röntgen rays—conditions producing the most complete polarisation—he has found that the intensity of radiation in a direction opposite to that of propagation of the primary rays, as experimentally determined, is within 5 per cent. of that calculated on the ether-pulse theory. Until the electric-doublet theory can do this the ether-pulse theory holds the field.
R. S. W.

624. *Action of Turpentine Vapour on a Photographic Plate.* **A. G. Cingovatov.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 39. No. 6. pp. 186–189, 1907.)—Photographic plates are acted on when exposed for some hours to the action of turpentine vapour, subsequent development of the plates indicating clearly the parts exposed to the vapour. T. H. P.

625. *The So-called Moser Rays.* **E. Légrády.** (Zeitschr. wiss. Phot. 6. pp. 60–68, Feb., 1908. Photographic Journ. 48. pp. 205–207, April, 1908.)—The author has investigated the effect produced in the dark upon a photographic plate by certain metals. The effect has been attributed to the action of H_2O_2, and also to the giving-off of rays from the metal surface. A series of experiments were made with different metals in moist and dry H_2, O_2, and N_2, and it was found that the presence of water vapour is essential for the action to take place. The conclusion is drawn that the action is due to hydrogen ions and not to H_2O_2 at all. E. C. C. B.

626. *Variations in Radio-active Transformations.* **E. Meyer** and **E. Regener.** (Deutsch. Phys. Gesell., Verh. 10. 1. pp. 1–18, Jan. 15, 1908.

Physikal. Inst. d. Univ., Berlin. Ann. d. Physik, 25. 4. pp. 757–774, March 31, 1908.)—The exponential law of radio-active transformation is strictly observed only when the number of atoms in process of transformation is large. Otherwise there are oscillations about the normal value, distributed according to the law of errors. E. v. Schweidler has shown that the mean oscillation has an amplitude proportional to $Z^{-\frac{1}{2}}$, where Z is the normal number of atoms transformed in unit time. The authors succeeded in observing the variations in the case of polonium preparations, and confirmed the law within 1 per cent. On reducing the capacity of the electrometer, larger variations were observed. Assuming v. Schweidler's law $\epsilon = Z^{-\frac{1}{2}}$ as correct, the amount may be calculated from the saturation current, every one of the Z particles producing 94,000 pairs of ions. The current generated per sec. is $94000\,Ze$, where e is the charge of an electron. If δ is the time over which the transformation is integrated (*i.e.*, the period of the needle), we have $\epsilon = 94000e/\sqrt{(i\delta)}$, where i is the saturation current. This gives a new method of calculating e, which yields the value $1{\cdot}3 \times 10^{-10}$. This shows, at all events, that the method can be used for this purpose. E. E. F.

627. *Decay of Radium B and C at High Temperatures.* **H. W. Schmidt.** (Phys. Zeitschr. 9. pp. 113–117, Feb. 15, 1908. Physikal. Inst. d. Univ., Giessen, Jan., 1908.)—The radium preparation is sealed in a quartz tube and placed in an electric oven in close proximity to a thick-walled zinc dispersion vessel containing a leaf electroscope. The thickness of the walls of the vessel and of the oven is so great that the ionisation is produced entirely by γ-rays. The results are plotted in the form of curves, the logarithm of the intensity of radiation being taken as ordinate and time as abscissa. The curves are approximately straight lines, although the temperature differs considerably in different experiments, and even in the same experiment. Hence it is concluded that the rate of decay of RaC is constant, up to a temperature of 1,300° C., or at any rate the deviation from constancy is less than the error of experiment. An experiment upon a Pt wire rendered radio-active shows that the decay of induced activity follows the same law at high as at low temperature. S. G. S.

628. *Specific Radio-activity of Uranium.* **H. N. McCoy** and **W. H. Ross.** (Amer. Chem. Soc., Journ. 29. pp. 1698–1709, Dec., 1907. Contribution from the Kent Chem. Lab., Univ. of Chicago.)—New determinations of the specific activity of uranium minerals under conditions so chosen that the α-rays of the active films all reach the limits of their ranges in the air of the ionisation chamber, show that the specific activity of uranium in minerals, corrected for the deficiency due to loss of emanation, is 3616, the corresponding constant for pure uranium compounds being 796. So that, for equal uranium content, minerals free from thorium are $3616/796 = 4{\cdot}54$ times as active as pure compounds. The relation between the activities of equilibrium amounts of uranium and radium in a mineral is 1·87. The range of uranium is about 3·4 cm., and it is considered probable that there is a new uranium product which gives α-rays with a range of 3·25 cm. To explain the supposed genetic relationship of actinium to uranium, it is suggested that uranium X may disintegrate in two ways, the first giving β-rays and the inactive product which finally produces radium, and the second and much slower change resulting in α-rays and actinium. T. H. P.

629. *Specific Radio-activity of Thorium and the Variation of the Activity with Chemical Treatment and with Time.* **H. N. McCoy** and **W. H. Ross.**

(Amer. Chem. Soc., Journ. 29. pp. 1709–1718, Dec., 1907. Contribution from the Kent Chem. Lab., Univ. of Chicago.)—The authors have previously shown [Abstract No. 1578 (1906)] that the radio-activity of thorium minerals, less the activity due to uranium present, is proportional to the content of thorium. The determinations of the specific activity of thorium which are now described, and which were made with films deposited on flat plates and under such conditions that all the α-rays reach their maximum ranges in air [see preceding Abstract], give the value 1,009, the unit being the activity of 1 cm.^{2} of a thick film of U_3O_8. The direct separation of radiothorium from thorium by chemical processes is found to be extremely difficult, if not impossible. The diminution of activity of thorium previously observed after certain chemical treatments are completely explained by Hahn's hypothesis [Abstracts Nos. 1237 and 1577 (1906)] of the existence of an intermediate product—mesothorium—between thorium and radiothorium. This product is easily removed by the chemical treatment referred to, the radiothorium then undergoing gradual decay. If all the mesothorium be removed at one time in the preparation from a mineral of pure thorium dioxide, the activity of the latter will fall to a definite minimum. From the activity of a sample of thoria supposed to have reached this minimum, the period of mesothorium is calculated to be 5·5 years; the quantitative changes of activity with time of a number of samples of thoria agree well with the values calculated from this period. T. H. P.

630. *Ionium in Uranium Ores.* **W. Marckwald** and **B. Keetman.** (Ber. Deut. Chem. Gesell. 41. p. 49, 1908. Chem. News, 97. p. 75, Feb. 14, 1908. Abstract.)—A hitherto unknown radio-active constituent has been discovered in pitchblende from Joachimstal or German East Africa, and in autunite, having properties identical with those of ionium described by Boltwood and Hahn. It may be separated, together with thorium, by dissolving the ore in HNO_3, converting into sulphate, filtering off the sulphates of Pb, Ba, and Ra, and adding hydrofluoric acid to the filtrate, whereby the fluorides of cerium and yttrium earths and of thorium are thrown down as a strongly active precipitate. This is again dissolved by evaporating with H_2SO_4, and oxalic acid added to the strongly acid solution, when almost all the activity separates with the thorium oxalate. More than two-thirds of the radio-activity of the substance is absorbed by Al-foil of 0·007 mm. thickness, and its ionising power compared with that of radium, separated from the same amount of ore, is as 7 : 10; no emanation is given off. Thorium and ionium carbonates are both soluble in ammonium carbonate, hence the ionium will be found in the mother-liquor of the manufacture of uranium. Autunite contains less than 1 part in 100,000 of lead, if any. W. H. Sт.

631. *Proportion of Thorium in the Soil at Rome.* **G. A. Blanc.** (Accad. Lincei, Atti, 17. pp. 101–106, Feb. 2, 1908.)—The amount of thorium in the soil at Rome, determined by comparing the total effect on a negatively charged filament, of the thorium A, B, and C, in a definite area of soil, with that of a mixture of earth containing 11·11 per cent. thorium hydroxide, is not less than 0·0000145 gm. per gm. of earth. Since thorium hydroxide is the most active compound of the metal known, if present in any other form the quantity of thorium would be higher. W. H. Sт.

632. *Radio-activity of the Atmosphere in the Gulf of Liguria.* **D. Pacini.** (N. Cimento, 15. pp. 24–28, Jan., 1908.)—From measurements of the rate of

decay of the activity induced on a negatively charged wire exposed for 9 hours in the Gulf of Liguria at some 15 miles from the coast, it is concluded that the induced radio-activity is due almost entirely to radium, and that there is no appreciable trace of thorium. W. H. Si.

633. *Rate of Decay of excited activity from the Atmosphere.* **S. G. Lusby** and **T. Ewing.** (Roy. Soc. N.S. Wales, Journ. and Proc. 40. pp. 158–160, 1907.)—No previous determination of this quantity has been published for Australia. A copper wire 10 m. long is suspended vertically and kept charged negatively to 25,000 volts for 3 hours. It is then rubbed with cotton-wool moistened with ammonia, the wool incinerated, and the ashes tested for radio-activity in the usual way. The half-value period is 40·9 min. as the mean of four determinations. Rutherford and Allan have given the number 45 min.; the curve of their results appears really to give 41·7 min. R. S. W.

634. *Origin of the Highly Penetrating Radiation.* **W. W. Strong.** (Nature, 77. p. 348, Feb. 13, 1908. Science, 27. pp. 351–353, Feb. 28, 1908. Terrestrial Magnetism, 12. pp. 145–148, Dec., 1907. Phys. Zeitschr. 9. pp. 117–119, Feb. 15, 1908.)—Three reasons are given for supposing that a part of the ionisation in closed vessels is produced by a penetrating radiation which is not due to radium in the earth, but to radio-active products in the atmosphere, whose origin is very likely to be the radium in the earth's surface layers. The first reason is founded upon a calculation of the radiation produced by the radio-active contents of the surface materials as found by Strutt and Eve. Taking into account the known absorption-coefficient of these materials, it is found that the ionisation produced would be much less than that actually observed. In the second place, measurements are made, the electroscope being so situated that it could be surrounded by an envelope of water 4 ft. thick. Without the envelope the daily variation of ionisation is considerable, which would not be the case if it were due to the radium content of the earth. Also after a shower the ionisation is reduced to a very small amount. In the third place, the ionisation in cavities at considerable depths should be double that near the surface if due to radium in the earth; but it is found to be small, in fact, of the same amount as that observed when the water envelope is employed in the last case. S. G. S.

635. *Lithium in Radio-active Minerals.* **Mlle. Gleditsch.** (Comptes Rendus, 146. pp. 331–333, Feb. 17, 1908.)—The proportion of lithium in several radio-active minerals has been determined by spectroscopic examination, and compared with the amount of copper present. The following results show that there is no direct relation between them:—

	Copper, Per Cent.	Lithium, Per Cent.	Activity, compared with Uranium.
Pitchblende from Joachimstal......	1·2	0·00017	1·5
Pitchblende from Colorado.........	0·15	0·00034	1·75
Carnotite	0·15	0·030	0·52
Chalcolite from Cornwall............	6·54	0·00011	2·0
Autunite	0	0·00083	1·48
Thorite	trace	0·0033	0·59

W. H. Si.

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636. *The Expansion of Mercury.* **P. Chappuis.** (Ann. des Poids et Mesures, 13. pp. *c*3–*c*31, 1907.)—The weight-thermometer method is used, the reservoir being of *verre dur*, over 1 m. long, to which is connected a capillary tube. First, the linear expansion of the reservoir is found under the comparator, whence is deduced its cubical expansion—

$$V_T - V_0 = V_0(0{\cdot}0000216963T + 0{\cdot}000000016384T^2).$$

One series of observations is taken at 0°, another series at 100°, and another at 10°, while other temperatures up to 44° are taken. The result thus obtained for mercury is—

$$1 + K(T)_T = 1 + 0{\cdot}000181690T - 0{\cdot}0000000002951T^2 + 0{\cdot}00000000011456T^3.$$

Besides this direct method the author uses an indirect one, founded on a comparison previously made between the mercury-scale thermometer in *verre dur* and the hydrogen thermometer. The supposition is here made that the expansion of the glass is the same as in the above weight thermometer. This supposition is not verifiable, so the indirect method only serves as a control on the other. Nevertheless the two methods show differences between −20° and +100° of never more than 5 in millionths. They are in much better agreement than are the results of Wüllner or Broch with them or with one another. P. E. S.

637. *The Expansion of Water.* **P. Chappuis.** (Ann. des Poids et Mesures, 13. pp. *d*3–*d*40, 1907.)—The weight-thermometer method is employed. Two reservoirs, each over 1 m. long, are used: (1) *Verre dur;* (2) iridio-platinum. The water in expanding forces mercury out of a capillary tube and the expelled mercury is then weighed. The standard temperatures of 0° C. and boiling-point of water as well as several intermediate temperatures up to 42° are used. The linear expansion of the glass reservoir was determined in the research on the expansion of mercury [see preceding Abstract], while the linear expansion of the iridio-platinum is ascertained by measuring the iridio-platinum standard scale placed by the side of the reservoir throughout the experiments. On comparing the results with those of Marck differences are found between 0° and 26° of +9 and −10 in millionths; but on comparing results with Thiesen the differences are much less, viz., −6 in millionths. The concordance between these results and those of Thiesen between 0° and 16° is exceedingly good, viz., differences of never more than 1 in millionths. A complete table of volumes and densities for every 1/10° between 0° and 40° is given. P. E. S.

638. *Gas Thermometers.* **P. Chappuis.** (Ann. des Poids et Mesures, 13. pp. *a*3–*a*66, 1907.) **D. Berthelot.** (Ibid. pp. *b*3–*b*113, 1907.)—In the first paper, the thermometric scales of hydrogen, nitrogen, and carbon dioxide are determined by comparison with well-standardised hard glass mercury thermometers, between −24° and +100°. The principal results are given in the following tables :—

	P_0 in mm.	α_{0-20}	α_{0-40}	α_{0-100}	β_{0-20}	β_{0-40}	β_{0-100}	Compressibility.		
								Pressure in m.	Temperature.	Formula.
Hydrogen	Near 1,000	—	—	0·00366004	—	—	0·00366256	1 to 1·3	0° 100°	$V_0=0{\cdot}000762+0{\cdot}999288P^{-1}$ $V_{100}=0{\cdot}000797+1{\cdot}365890P^{-1}$
Nitrogen	1001·855	0·0036770	0·00367497	0·00367315	0·0036754	0·0036752	0·0036744	1·095	0°	$V_0=-0{\cdot}0005712+1{\cdot}0005712P^{-1}$
	798·5	—	—	—	—	—	0·0036720	to		
	530·5	—	—	—	—	—	0·0036685	1·385	100°	$V_{100}=0{\cdot}000254+0{\cdot}999746P^{-1}$
Air	Near 1,000	—	—	0·00367282	—	—	0·00367441	—	—	—
Carbon dioxide	0 (by extrapolation	0·003661	0·003663	0·003671	—	—	0·003670	Near 1·0	0° 100°	$V_0=-0{\cdot}009060+1{\cdot}009060P^{-1}$ $V_{100}=-0{\cdot}004528+1{\cdot}378625P^{-1}$

	$\partial\alpha/\partial P_0$	$\alpha_{\lim.}$	$\partial\beta/\partial P_0$	$\beta_{\lim.}$
Hydrogen	0·00000186 (Amagat)	0·00366249	0	0·00366256
Nitrogen..............................	0·0000000119	0·0036612	0·0000000128	0·0036617

The amounts by which the temperature indicated by the gas thermometers exceed the actual temperature are shown in the following table :—

	Constant Volume.		Constant Pressure.		P_0, mm.
	20°.	40°.	20°.	40°.	
Hydrogen	0°	0°	0°	0°	1,000
Nitrogen	+ 0·005	+ 0·008	− 0·021	− 0·020	1,000
Air	+ 0·010	+ 0·007	—	—	1,000
Carbon dioxide	− 0·002	− 0·010	+ 0·029	+ 0·028	518
	+ 0·039	+ 0·039	+ 0·102	+ 0·133	998
	—	—	+ 0·142	+ 0·214	1,877

The compressibility of CO_2 for other temperatures and pressures was determined, and a table is given for pressures from 700 to 800 mm. at intervals of 1 mm. P_0 is initial pressure, α and β are the coefficients of dilatation at constant pressure and constant volume respectively, the suffixes denoting range of temperature. α_{lim} and β_{lim} are the zero pressure values [see also Abstract No. 124 (1905)].

In the second paper it is pointed out that current generalisations of gas theory depend on hazardous extrapolation beyond the temperature limits, usually 0° and 100°. From Chappuis' data, given above, the absolute zero is —273·08° C., *i.e.*, the inverse of the coefficient of dilatation of the perfect gas. The results of all published data agree well with the formula—

$$d(\pi v)/d\pi = \frac{1}{4}(1 - 6/\theta^2),$$

where π, v, and θ are the reduced pressure, volume, and temperature, *i.e.*, the ratio of pressure volume and temperature respectively to the critical pressure, volume, and temperature. Van der Waals' equation is modified accordingly, and certain consequences developed in detail. The above formula is applied to the study of the problems of constant-volume and constant-pressure thermometers, and, using only observed values of the critical constants of each gas, it is found that there is complete accordance between theory and observation. F. R.

639. *Expansion of Quartz Glass.* **K. Scheel.** (Deutsch. Phys. Gesell., Verh. 9. 23. pp. 718–721, Dec. 15, 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—The expansion of a ring of quartz glass was measured with Fizeau's apparatus. A minimum size was discovered at — 84° C., instead of — 46° C., as in the case of the quartz cylinder previously examined. A rod of quartz which at 0° C. would be 1 m. long, would appear shortened by 18 μ at — 84° C. The expansion produced by heating quartz 1 m. long from 0° C. to 100° C. is 50 μ, which agrees well with results obtained by Chappuis and by Holborn and Henning. The expansion is practically linear above 0° C. E. E. F.

640. *Apparatus for determining the Mechanical Equivalent of Heat.* **N. A. Smirnov.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 39. No. 5. pp. 129–132, 1907.)—In this apparatus, in which the systematic errors are reduced to a minimum, an electric motor, regulated by a rheostat, rotates at a speed o

1,900 r.p.m. two well-polished discs, 10 cm. in diam., immersed in the water of the calorimeter. The appearance of waves or of a funnel formation in the water is prevented by projections and by the cover slightly below the surface of the liquid. The calorimeter is free to turn about its vertical axis; the couple tending to make it assume a position of rest having been measured, the friction couple and the work of the motor are determined. T. H. P.

641. *The Absolute Thermodynamic Scale of Temperature.* **J. Rose-Innes.** (Phil. Mag. 14. pp. 301–316, March, 1908.)—The author shows how to calculate the thermodynamic corrections which have to be applied both to constant-pressure and constant-volume gas thermometers. For the hydrogen and nitrogen thermometers the following table is given:—

	Temp. in Degrees Centigrade.	Correction to be Subtracted.		Temp. in Degrees Centigrade.	Correction to be Subtracted.	
		Const. Press.	Const. Vol.		Const. Press.	Const. Vol.
Hydrogen	0	0	0	60	0·0023	0·0015
	10	0·0011	0·0007	70	0·0019	0·0013
	20	0·0018	0·0012	80	0·0014	0·0010
	30	0·0023	0·0015	90	0·0008	0·0005
	40	0·0025	0·0016	100	0	0
	50	0·0025	0·0016			
Nitrogen	0	0	0	60	0·0163	0·0026
	10	0·0074	0·0011	70	0·0138	0·0022
	20	0·0126	0·0019	80	0·0102	0·0016
	30	0·0159	0·0025	90	0·0056	0·0009
	40	0·0175	0·0027	100	0	0
	50	0·0176	0·0028			

In the above table the constant-pressure thermometer is supposed to be under the pressure of 1 atmo., and the constant-volume thermometer is supposed to be under the pressure of 1 atmo. at the freezing-point. The results show that the thermodynamic corrections to the constant-volume thermometer are small quantities when we employ hydrogen or nitrogen at standard density. In the case of hydrogen, the nature of the walls of the containing vessel appears to exert a perceptible influence upon the pressure of the gas. The author points out the practical importance of repeating the Joule-Kelvin porous-plug experiments over a wide range of temperature. A. R.

642. *The Joule-Kelvin Inversion Temperature and Olszewski's Experiment.* **J. D. H. Dickson.** (Phil. Mag. 15. pp. 126–146, Jan., 1908.)—In the Olszewski experiment [Abstract No. 858 (1902)] a finite time is occupied in the release of the gas under pressure, thus differing from the method employed by Joule. There is also a departure from the Joule-Kelvin porous-plug experiment in employing a great difference of pressures and in restoring the small aperture in place of the porous plug. The question arises whether the theory of the Olszewski experiment is the same as that of the Joule-Kelvin one, and, if it is not, what the theory of the former is. The question of what is meant by the Joule-Kelvin inversion temperature also arises. The author gives a mathematical investigation of these questions, and answers the last question thus: Gas is allowed to expand through a porous plug from a high pressure of any magnitude to a lower pressure subject to certain conditions, namely, it must enter and leave the neighbourhood of the plug at the same temperature; some considerable time must elapse between the starting of the experiment and the commencement of the observations, so that the flow of gas may be steady both as regards pressure and temperature; the gas must leave the plug with kinetic energy differing so little from that with which it approaches the plug that this difference may be neglected; then the temperature in question is an inversion-temperature for the gas concerned and the pressures employed. As regards the general circumstances in which a given temperature may be an inversion-temperature, it is found that for such a temperature two isopiestics must intersect, and the author distinguishes between an inversion-point and an inversion-temperature. The conclusion is reached that on the data, and employing van der Waals' equation of state, the physical nature of Olszewski's experiment has still to be determined. Olszewski's recent observations on air and nitrogen confirm this conclusion, and the author considers that Olszewski's experiment, although an expansion experiment like the Joule-Kelvin one, yet differs essentially from the latter. The writer of the paper concludes that while the Olszewski experiment and the van der Waals' equation may each assist each other in the progress towards truth, yet on the conditions assumed there is apparent incompatibility between them. This does not affect the purpose nor the success of Olszewski's experiment, which was undertaken to determine a temperature suitable for moderate pressures such that if expansion of a gas be made below that temperature cooling will take place. J. J. S.

643. *Internal Friction and Density of the Bunsen Flame.* **A. Becker.** (Ann. d. Physik, 24. 5. pp. 823–862, Dec. 31, 1907.)—This paper contains, first of all, measurements of the lifting force of the Bunsen flame as measured by small spheres of glass carried on platinum wires and attached to the arm of a delicate torsion balance. Observations were made in various parts of the flame and also in the dark cone, and, further, the relation between the lifting force and the size of the sphere was determined. The velocity of the gas currents in the flame was determined by means of a tuning-fork; to one arm of the fork was attached a small brass tube containing naphthalene, which was immersed in the flame. The vapours of the naphthalene made a luminous flame which, when the fork was vibrating, formed a series of waves. The velocity of the gas current was determined from the pitch of the fork and the length of the waves. The lifting force was also determined in the case of currents of other gases of known velocity, viz., H_2, O_2, air, and CO_2. From these data the coefficient of internal friction of the Bunsen flame was calculated and found to be $\eta_0 = 0{\cdot}000148$ for the dark central cone and $\eta = 0{\cdot}000444$ for the flame, whence $\eta_0 = 0{\cdot}000152$. E. C. C. B.

REFERENCE.

644. *Principle of Variation in Thermodynamics.* **M. Born** and **E. Oettinger.** (Phys. Zeitschr. 8. pp. 572–580, Sept. 1, 1907.)—By methods of the calculus of variations it is shown that, if isolated systems are not in thermal equilibrium, changes of state ensue in the direction of increasing entropy which attains a maximum value when equilibrium is established. R. E. B.

SOUND.

645. *Highest Audible Tones.* **F. A. Schulze.** (Ann. d. Physik, 24. 5. pp. 785–822, Dec. 31, 1907. Physikal. Inst. d. Univ., Marburg.)—Gives an account of various methods for determining the frequencies of high tones either just audible or above the superior limit of audition. These include Chladni's figures, Kundt's dust figures, Galton's whistle, and the longitudinal vibrations of wires. The author finds by any of these methods, in spite of the differences of intensity, that the upper limit is the same, namely, about 20,000 per sec. [see also Abstract No. 1368 (1899)]. E. H. B.

646. *Harmonics of a Vibrating Body.* **G. Sizes** and **G. Massol.** (Comptes Rendus, 146. pp. 24–26, Jan. 6, 1908.)—Referring to their previous paper [Abstract No. 89 (1908)], the authors now classify the various partials and refer them to the tone (fa_{-1}), reserving for it the name *fundamental*, and calling the tone (ut_0), which represents what is usually called the pitch of the fork, the *predominant.* On this system all the tones have frequencies which are multiples of that of the *fundamental,* the predominant (ut_0) having the frequency 32 to the fundamental (fa_{-1}) 1/3 per sec., or 96 times. E. H. B.

647. *Simple Method for Intensity of Sound.* **G. W. Pierce.** (Amer. Acad., Proc. 43. No. 13. pp. 377–395, Feb., 1908. Contribution from the Jefferson Phys. Lab., Harvard Univ.)—In the course of a series of experiments on detectors for electromagnetic waves the author found a number of solid substances which, when supplied with contact electrodes and put into electric circuits, serve as rectifiers for small electric oscillations [see Abstract No. 1575 (1907)]. Some of these substances used in connection with a galvanometer prove to be extremely sensitive and constant in their action, and permit the measurement of the currents generated by the vibration of the diaphragm of a magneto-telephone under the action of sound waves even when the telephone is at a considerable distance from the source of sound. With the use of this device the relative intensity of sound at different positions in a room may be measured, and many interesting results as to the acoustic properties of an auditorium may be obtained. The present paper deals specially with the use of the molybdenite rectifier in the measurement of sound. Molybdenite, MoS_2, is a mineral occurring in nature in the form of hexagonal prisms with eminent cleavage parallel to the base, and may be scaled off in thin sheets, a few cm.^{2} in area, resembling bits of tin-foil. In the present experiments a thin sheet so obtained was mounted so as to be touched at its centre and round its periphery by the brass pieces through which the currents pass. This rectifier was at first placed directly in series with a sensitive galvanometer and a Bell magneto-telephone receiver. With this arrangement, when sound was made in the neighbourhood of the receiver, the vibration of the telephone diaphragm generated electric oscillations in the circuit. These oscillations passed through the rectifier more strongly in one direction than in the opposite, and so caused a deflection of the galvanometer. However, on account of the high resistance of the rectifier, and in order to take advantage of electrical resonance in the circuits, it was found better to

employ an arrangement of two circuits involving a step-up transformer. Thus one circuit contained the telephone, an adjustable condenser, and the primary of the transformer, while the other circuit contained the secondary of the transformer, the rectifier, the galvanometer, and a calibrating device. In using this arrangement to respond to a particular note (in some tests an organ-pipe of frequency 705 was used) the condenser was adjusted till the maximum deflection was obtained. Different parts of various auditoriums were then explored, and the relative intensities of the sound from given sources are plotted as curves with distances as abscissæ. With pure tones and rooms with reflecting walls, a number of well-marked maxima and minima due to interference are clearly established. E. H. B.

648. *Sensibility of the Ear to Direction of Explosive Sounds.* **A. Mallock.** (Roy. Soc., Proc. Ser. A. 80. pp. 110–112, Feb. 13, 1908.)—Soon after the introduction of modern rifles, which give their projectiles a velocity much higher than that of sound, the author noticed that when standing in a position in front of the gun and not far from the line of fire, the sound seemed to come, not from the firing-point, but from some point considerably in advance of the gun. The natural explanation seemed to be that the sound thus heard was not that of the explosion itself, but was caused by the wave surface, which is generated in the air by the projectile, moving at a velocity higher than sound. In 1898 some observations were made to test this point, but the range, having many parties firing together, was not suitable. The experiments now recorded were made under more favourable conditions. It is clear that the sound from the wave caused by the projectile will have an apparent direction normal to the wave surface, and that if the direction of this normal is known the velocity of the projectile, at the time that that particular portion of the wave surface was generated which ultimately reaches the observer, could be calculated. The present observations are recorded, not as giving a practical method of ascertaining the velocity of projectiles, but as showing that the ear can distinguish with considerable accuracy the direction of a sound which consists, not of a train of waves, but, at most, of two waves only. The paper includes a plan showing the range, the nine observing stations, the apparent directions, and the inferred velocities of the projectile along its course. At each station a piece of paper fixed to a drawing-board was placed on the ground, and a line ruled on it was directed to the firing-point. At each shot the observer determined in his own mind from what point on the horizon the sound seemed to come (located by some tree or other object), and a line was then drawn on the paper in that direction. The results show that the sound always appeared to come from points in advance of the gun; and, on the assumption that they were due to the wave surface from the projectile, the speeds were calculated and found to be in good agreement with the determinations of a ballistic pendulum. E. H. B.

REFERENCE.

649. *Helmholtz's Resonance Theory of Hearing.* **O. Fischer.** (Ann. d. Physik, 25. 1. pp. 118–134, Jan. 17, 1908.)—A detailed anatomical and physical discussion of the above theory with special reference to an article by M. Wien (Wüllner-Festschrift, 1905). E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

650. *Residual Charges and Dielectric Hysteresis.* **E. v. Schweidler.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 1019–1080, June, 1907. Baumgartner Prize Essay. Ann. d. Physik, 24. 4. pp. 711–770, Dec. 17, 1907.)—Under the general title of "dielectric anomalies," the author comprises residual charges, the conversion of electrical energy into heat in an alternating field, the mechanical forces exerted upon a dielectric in a rotating field, and the dependence of capacity upon time of charge. He does not approve of the term "dielectric hysteresis." He shows that all the anomalies depend upon the residual charge, and can be calculated as soon as that is known. As regards existing theories, Maxwell's theory of conducting particles immersed in a non-conducting medium gives the phenomena qualitatively, but does not admit of mathematical formulation. Anomalous conduction (by ions) leads to results at variance with experiment. A dielectric hysteresis or after-effect in the magnetic sense is not admissible. The only hopeful theory is that of Pellat's viscous dielectric hysteresis, according to which the displacement due to a field E at a time t equals $D=KE+(1-e^{-at})\epsilon KE$, when a and ϵ are two constants characteristic of the dielectric. This formula leads qualitatively to the observed results, except as regards the time function. The time t enters, not in the form e^{-at}, but in the form Bt^{-n}. The author substitutes for $\epsilon(1-e^{-at})$ a sum $\Sigma\epsilon(1-e^{-at})$ of similar functions, which enables him to arrive at any desired value of $f(t)$. This modification of Pellat's theory is capable of a physical interpretation. Pellat assumes the instantaneous mutual displacement of some molecular doublets consisting of electrons and positive atoms, and (in anomalous dielectrics) the simultaneous gradual or viscous displacement of other ions in accordance with the exponential formula given above. The author's modification consists in assuming the existence of a large variety of these viscous ions, with different periods of displacement. The author shows how all the anomalous phenomena may be calculated when two constants are known, and these may be determined by observing the residual current. He adds some experiments of his own which confirm the principle of superposition, the influence of temperature, and the proportionality between residual current and field. A list of 150 articles on the same subject is appended. E. E. F.

651. *Capacity of a nearly Spherical Conductor.* **K. Aichi.** (Mathematico-Physical Soc., Tōkyō, Proc. 4. 12. pp. 243–246, Jan., 1908.)—The author proves that the capacity of a nearly spherical conductor is very approximately equal to $\sqrt{S/4\pi}$, where S is the surface of the conductor. To a first approximation, therefore, the capacity of a nearly spherical conductor depends on its surface alone. If the equation to the surface of an ellipsoidal conductor is—

$$x^2/a^2+y^2/b^2+z^2/c^2=1,$$

its capacity is known to be $\sqrt{a^2-c^2}/F(k,\phi)$, where $\phi=\sin^{-1}\sqrt{a^2-c^2}/a$ and the modulus k equals $\sqrt{a^2-b^2}/\sqrt{a^2-c^2}$. Now the surface S is given by $S=2\pi c^2+2\pi b\sqrt{a^2c^2}E(k_1,\phi)+2\pi bc^2F(k_1,\phi)/\sqrt{a^2-c^2}$. Writing $a^2=1$ and putting $b^2=1-\gamma$ and $c^2=1-\delta$, it is proved that when γ and δ are small $(S/4\pi)^{\frac{1}{2}}=1-(\gamma+\delta)/6-17(\gamma^2+\delta^2)/360+\gamma\delta/180\ldots$ Similarly by expanding $\sqrt{a^2-c^2}/F(k,\phi)$ the same algebraical expression is found. Hence as far as the *second order* of small quantities, $(S/4\pi)^{\frac{1}{2}}$ gives the capacity of an ellipsoidal conductor which is nearly spherical. A large number of numerical examples are worked out to show that even when the ellipsoid departs very considerably from the spherical shape, $(S/4\pi)^{\frac{1}{2}}$ represents the capacity K very approximately. For example, when $a=1$, $b=0{\cdot}9$, $c=0{\cdot}8$, we have $(S/4\pi)^{\frac{1}{2}}=0{\cdot}89895$ and $K=0{\cdot}89890$. Also when $a=1$, $b=0{\cdot}7$, $c=0{\cdot}5$, $(S/4\pi)^{\frac{1}{2}}=0{\cdot}7270$ and $K=0{\cdot}7274$; and when $a=1$, $b=0{\cdot}3$, $c=0{\cdot}1$ we have $(S/4\pi)^{\frac{1}{2}}=0{\cdot}4465$ and $K=0{\cdot}4264$. A. R.

652. *Atmospheric Electricity and Fog.* **C. Chree.** (Nature, 77. p. 343, Feb. 13, 1908.)—A note calling attention to the fact that during fog specially high positive potential gradients occur. During 8 years—1898 to 1904—the mean value of the potential gradient at Kew was 159. On the morning of Jan. 21, 1908, during an intensely thick fog, the potential gradient at Kew exceeded 730 continuously from 1 to 9.30 a.m. There are usually large and frequent oscillations in the value of the gradient, so that the maintenance of an exceptionally high value for a number of consecutive hours is rare. During the time mentioned the trace was beyond the limits of registration, so that how high the maximum value was is not known. J. J. S.

653. *Ionisation of the Air on Land and Sea.* **D. Pacini.** (N. Cimento, 15. pp. 5–23, Jan., 1908.)—Observations have been made on land at various altitudes and on the sea, using a modification of the Ebert instrument. The following are the mean results obtained, where E represents the quantity of electricity per cm.³ of air, $q=E_+/E_-$, and n_+ and n_- are the number of positive and negative ions respectively in 1 cm.³ divided by the density :—

Place.	E_+	E_-	q	n_+	n_-	Atmospheric Conditions.
Rome	1·140	0·980	1·16	8,350	2,880	Sky clear.
Forme (Central Apennines, 1,000 m. above sea-level)...	0·601	0·380	1·58	1,770	1,140	Sky clear.
Mt. Velino (2,487 m. above sea-level)...	0·682	0·123	5·58	2,020	806	Sky almost clear, wind W.
Ligurian Sea (15 miles from coast)	0·431	0·282	1·52	1,270	820	Sky fairly clear, wind SE., sea slightly rough.
Ligurian Sea (7 miles from coast)	0·183	0·099	1·84	540	290	Sky cloudy, wind SE., sea slightly rough.
Ligurian Sea (21 miles from coast)	0·232	0·108	2·14	680	320	Sky clear, wind SE., sea rough, much spray.

With a clear sky and calm sea the electrical condition of the air, even at a considerable distance from the shore, is very similar to that on the mainland. This may be partly attributed to the fact that recombination takes place more slowly in the presence of water vapour, and partly also to the Lenard effect. W. H. Sr.

654. *Dissipation of Electricity by Uniform Air-currents.* **E. Riecke.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 5. pp. 571–575, 1907.)—The author showed in 1903 that the dissipation of the charge on a sphere should, within restrictions, be independent of the movement of the air. The experimental proof was given by H. Schering, and the velocity of the air-currents has been found to be immaterial in the Gerdien-Schering apparatus for determining the conductivity of the air. The author now proves that his formula for a sphere also holds for the loss of charge from a horizontal wire. If $-\eta$ is the negative electric charge per unit length of wire, c the velocity of light, U the absolute velocity of the positive ions, μ the velocity of the air moving in the direction of the negative X-axis, then all the ions which the air brings to a wire-section of length l will be contained within a cylinder whose cross-section at a great distance from the wire will be $4\pi c\eta l U/u$, while the air volume streaming through this cylinder per sec. will be $4\pi c\eta l U$. If $\overset{+}{N}$ be the number of positive ions per unit volume, ϵ the elementary charge, then the quantity of positive electricity deposited per sec. on the wire-length l will be $4\pi c\eta l\epsilon\overset{+}{N}U$, and this will also be the loss of negative charge per sec. If the total charge on the wire-length l is ε, then the loss per sec. from a negatively-charged wire will be $\delta\varepsilon/\varepsilon = 4\pi c\epsilon\overset{+}{N}U$; if the charge of the wire is positive, $\overset{-}{N}$ will enter into the same formula. H. B.

655. *Variations of Terrestrial Potential.* **A. Nodon.** (Comptes Rendus, 145. pp. 1370–1371, Dec. 23, 1907.)—In a previous note [Abstract No. 2079 (1907)] the author has described a new experimental arrangement for measuring variations of terrestrial potential, suggesting that rapid variations of large amplitude appeared to indicate approaching atmospheric storms. Further work indicates that the potential is practically constant during intervals of fine weather. Storms are indicated by variations often exceeding 100 volts per min. The method would appear to be of considerable use in predicting the approach of great storms and earthquakes. C. P. B.

656. *Electrical Dispersion in a Closed Underground Space.* **G. C. Trabacchi.** (Accad. Lincei, Atti, 17. pp. 106–107, Feb. 2, 1908.)—Experiments in, and just above, a subterranean passage, 50 m. long and 5 m. below the surface, which is traversed by a well-known mineral spring near Sangemini, the temperature being 15° C., and the air saturated with moisture, have given the following results, measured with an Elster and Geitel electrometer:—

Dispersion Outside.		Dispersion Inside.	
Time in Minutes.	Potential in Volts.	Time in Minutes.	Potential in Volts.
0	350	0	350
8	150	66	150

The great difference in the results cannot be attributed to the saturation of the air inside the passage with humidity, the effect of this being only very slight. W. H. St.

DISCHARGE AND OSCILLATIONS.

657. *Electric Discharge in Monatomic Gases.* **F. Soddy** and **T. D. Mackenzie.** (Roy. Soc., Proc. Ser. A. 80. pp. 92–109, Feb. 18, 1908. Engineering, 85. pp. 163–166, Jan. 31, 1908.)—In a previous paper it has been shown that helium and argon which have been thoroughly freed from other gases and vapours show a great disinclination to conduct a discharge [Abstract No. 725 (1907)]. The object of the present paper is to settle whether electric conduction in monatomic gases is essentially different from that in other gases. It is found that helium which has been subjected to the prolonged action of the discharge between aluminium electrodes, after initial purification with calcium, exhibits an extraordinary resistance to the passage of current. In an ordinary spectrum tube such helium offers a resistance equal to that of a 1-in. spark-gap, and the discharge is accompanied by the well-known characteristics—fluorescence of the tube, kathode rays, &c.—which are usually supposed to be indicative of a high vacuum. At atmospheric pressure helium conducts the current from a small induction coil with ease. To explain these facts it is only necessary to regard the helium molecule at all pressures as only about one-fifth to one-tenth as effective electrically as a molecule of a common gas like hydrogen. Helium, like other gases, is absorbed when a tube is run continuously. A large part of the gas is held by the Al film deposited on the surface of the glass from the electrodes, and is at once released when the film is dissolved in mercury. Helium becomes non-conducting at a pressure 0·6 mm. Tubes filled with argon cannot be run out to non-conductance by continuous use. Experiments with neon, argon, hydrogen, nitrogen, and carbon dioxide show that they also become non-conducting at pressures varying from 1/10 mm. to a few hundredths of a mm. A Röntgen-ray tube filled with helium gives rays showing the bones of the hand at 0·21 mm. These pressures are measured by a McLeod gauge specially designed to do away with rubber and tap-grease. These relatively high pressures may perhaps be explained in two ways. It is possible that previous investigators have not allowed sufficient time for the gas to diffuse throughout the apparatus; if the experimental tube in which the discharge is being observed has a constricted orifice, this diffusion will be extremely slow. A more important error, probably, is the presence of vapours which a compression gauge will not detect. These are thoroughly removed by the calcium furnace. An aluminium electrode once contaminated with one of the rare gases will retain enough to give a spectrum for months. The bubbles observed by Swinton in the walls of discharge tubes are especially copious in the case of argon, but it is doubtful whether they arise from gas driven into the glass by the discharge. With neon no gas could be collected after heating strongly, although the glass showed the usual bubbles, and only a faint trace with helium could be obtained under similar conditions. The bubbles are in all probability a secondary effect, due to the decomposition of the glass under the influence of local heating produced by the bombardment. R. S. W.

658. *Conditions affecting the Discharge of Electrodes in Ionisation.* **J. G. Davidson.** (Phys. Rev. 26. pp. 1–27, Jan., 1908. Dissertation, California Univ.)—An account of results that have been obtained concerning the conditions affecting the current in flames and from hot electrodes, together with some photo-electric effects. In flame conduction the temperature of the anode is varied by making it a metal tube and running water through it.

This is entirely without influence on the current. This is also found to be the case for the kathode, provided the flame is colourless and the metal free from traces of salts. Hence the conduction in flames is entirely due to ions in the midst of the flame gases. If the air-blast to a Bunsen flame is so regulated as to produce a sharply defined green cone, and the kathode placed in this cone, very large currents are produced. They are much greater than can be produced in any other part of the flame, even if the electrodes are heated electrically to the melting-point of platinum. According to the author, the positive ions which actually reach the kathode from salt vapour come from a very thin layer just outside the electrode. The view is put forward that the different convection methods of measuring the velocities of negative ions in flames are inaccurate, being based on the faulty assumption that at a certain critical voltage the field is just able to draw the ion from the kathode to the anode before it is carried away by the gas currents. In the experiments here described the same critical voltage is found for various positions of the anode. In studying the ionisation from hot metals it is very essential to free them from all traces of salts. The best way to do this is to dip the wire in acid and place it as an electrode in a flame with a large voltage applied, making it anode or kathode according as the absorbed material is alkaline or alkaline-earth. The positive leak from platinum observed by Richardson is ascribed to the presence of such impurities. Very large but brief leaks of positive ions can be obtained from hot platinum wires coated with alkaline salts. If a wire is held in regions of intense ionisation, it gathers on its surface material—probably molecular aggregates—which is easily ionised by ultra-violet light. The minimum in photo-electric sensitiveness of Pt wires at temperatures between 100°–200° is due to the action of occluded gases. The initial rapid decay of photo-electric activity discovered by Allen depends on the treatment to which the surface has been subjected. Stretching, twisting, or rasping a surface is found to increase the activity greatly. R. S. W.

659. *Discharge of Electricity from Pointed Conductors.* **J. Zeleny.** (Phys. Rev. 26. pp. 129–154, Feb., 1908.)—In a previous paper the discharge of electricity from cylindrical wires with hemispherical or flat ends was considered [Abstract No. 118 (1908)]. The present paper extends the investigation to conical conductors, such as ordinary steel needles. As before it is found that the current varies in a regular manner with the diam. of the point; the results are more regular when the point is positive than when it is negative. From the curves given it is possible to find the current that would flow in dry air to a plane 1·5 cm. distant, from points of any diam., at any potential, when these points are either steel sewing needles of the usual taper or 12° cones. The potential required to start a discharge from a point of any diam., and the current flowing at any potential can each be represented by a formula similar to the one given in the previous paper, provided the discharge is positive. The potential required to produce a current from the finest needles or cones is considerably greater than is necessary when fine cylindrical wires are used. Iron oxide is formed at the tips of steel needles during the positive discharge from them, and to a much less extent during the negative discharge. The negative discharge is irregular, especially for small currents. A point is placed at the centre of curvature of a hemisphere of metal which is built up in insulated sections; it is found that the current distributes itself quite uniformly over the surface of the hemisphere. As the gas pressure is diminished the discharge between a point and a plane takes place at lower and lower potentials, and the current increases more and more rapidly with increase of voltage. Below 1 cm. pressure the discharge potential drops rapidly to about 400 volts in air—*i.e.*, to a voltage approximately equal to the kathode-fall—at about 0·01 cm. it begins to increase rapidly. R. S. W.

660. *Gas-bubbles in the Glass of Crookes Tubes.* **A. A. Campbell Swinton.** (Engineering, 85. p. 181, Feb. 7, 1908.)—Pohl's conclusions that the observed results can be ascribed to a metallic film caused by disintegration of the aluminium electrodes [Abstract No. 2089 (1907)] is disposed of by the fact that bubbles are easily obtained in the glass walls of Crookes tubes which are excited by electrostatic induction from outside. R. S. W.

661. *Luminous Properties of Conducting Helium.* **P. G. Nutting.** (Electrical World, 51. pp. 390–392, Feb. 22, 1908. Abstract from Bureau of Standards, Bulletin. Illuminating Engineer, 1. pp. 338–340, April, 1908.)—The results given relate to the amount of light emitted laterally per unit length by a column of helium gas carrying a known current. The chief object of the investigation is to determine the constancy and reproducibility of such a source of light. Conducting helium emits light of a yellowish-white colour, which is better for photometric comparisons with a glow-lamp than light from any other of the permanent gases. Carbon dioxide, which emits a snow-white light, is next best, but it decomposes and disappears rapidly even with moderate current densities. Sulphur vapour emits bluish-white light, but its density is difficult to measure and control. Whilst the life of a tube of helium is 50 hours, a tube of hydrogen or nitrogen carrying the same current will only last about half an hour. A simple straight form of tube with disc electrodes of aluminium was adopted. The tubes were operated at an alternating pressure of 5,000 volts. The light emitted was compared with that of a 4-c.p. glow-lamp by means of a Lummer-Brodhun photometer. The uncertainty in each determination is about 2 per cent., the probable error being less than about 1 per cent. Tables or diagrams are given showing the variation of total candles emitted with current; the variation of light emitted with current in different tubes; the variation of potential gradient with current; the variation of light with gas pressure at various currents; the effect on the light emitted, of changing the nature of the current; the variation of light with gas pressure at different currents; the variation of the c.p. with the diam. of the bore; and the reproducibility of the helium gas lamp as a light standard. The last results are so promising that the helium tube seems to be worthy of consideration as a primary light-standard. No troublesome atmospheric corrections are required as in the Hefner, the Carcel, or the Pentane lamp. The uncertainties that arise are mainly those common to all methods of photometry which employ the eye of the individual observer as the measuring instrument. A. R.

662. *Charges on Positive and Negative Ions in Gases.* **J. S. Townsend.** (Roy. Soc., Proc. Ser. A. 80. pp. 207–211, March 5, 1908.)—If N be the number of molecules in 1 c.cm. of a gas at standard pressure and temperature, and e the charge on an ion, then the author has shown that $Ne = 3 \times 10^8\ U/k$, where U is the velocity of an ion in a field of unit electric force and k the coefficient of diffusion of the ions [Abstract No. 59 (1900)]. Thus from separate determinations of U and k the quantity Ne can be found. This gave that e on the negative ion was the same as in electrolysis; the results for the positive ions

were irregular. A method has now been discovered of determining Ne directly; the present paper contains the theory of the method. Two horizontal plates, A, B, are set at a distance h apart, and circular holes of the same radius are cut in the plates, the centres of the circles being in the same vertical line. In the circular aperture of the lower plate A an insulated metal disc D is placed so that it nearly fills the aperture. A grating of fine wire is laid across the hole in the upper plate B, and this plate is maintained at a potential V, higher than that of A. A third plate C is placed above B and is maintained at a potential V′, greater than V and of the same sign. The plate A and disc D are connected alternately to an electrometer, and their potentials during an experiment do not differ appreciably from zero. Ions are generated in the space between B, C by Röntgen rays, and positive or negative ions are driven through the grating according as the potential of C is positive or negative. These ions travel under a constant electric force Z towards D. At the same time some diffuse laterally and arrive on A. The ratio R of the number arriving at the disc to the total number is accurately determined by the electrometer. The mathematical investigation shows that R is a function of NeZ, *i.e.*, $R = \phi(NeZ)$. It is not necessary to know the form of the function ϕ in order to compare the charges on the ions. Experiments show that for the same Z the value of R is much greater for positive than for negative ions. The same value of R, within 1 per cent., is found for the two kinds of ions when the force for the negative ions is double that for the positive; *i.e.*, if e and e' denotes the charges on positive and negative ions respectively $\phi(NeZ) = \phi(Ne'2Z)$. Hence the charge on the positive ion is double that on the negative. This shows that when a molecule of air is ionised by Röntgen rays one positive and two negative ions are produced, the charge on the former being double that on the latter. The absolute values of Ne can be determined in Bessel functions: it is found that $Ne = 2{\cdot}41 \times 10^{10}$ for positive ions and $1{\cdot}23 \times 10^{10}$ for negative. On account of the larger charge on the positive ion partial recombination takes place quickly, with the result that the average charges on the ions of both sorts rapidly become equal, and this is probably the reason why the difference between the ions has not been placed in evidence earlier. R. S. W.

663. *Alternating-current Arc and Spark Discharge.* **D. A. Rożanskij.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 39. No. 6. pp. 161–177, 1907.)—The author shows that the theory of the alternating-current arc proposed by Simon [Abstract No. 1465 (1905)] can be developed analytically if the characteristic equation of the arc can be obtained in the simplified form. Experimental study of the characteristic curve of the oscillatory spark shows that in this form Simon's theory is applicable, and that the oscillatory spark may be regarded as an alternating-current arc of high frequency. The p.d. at the electrodes of the spark remains almost constant, and, for the maximum current, is approximately 85 volts. This value allows the decrement of the oscillations to be evaluated if the explosive potential is known. The author's theory confirms the increase of this decrement as the amplitude falls, and also explains how the resistance of the spark depends on the length of the latter and on the capacity, self-inductance, and decrement of the circuit.

T. H. P.

664. *The Hypothesis of the Stratified Structure of the Arc.* **H. Kayser.** (Zeitschr. wiss. Phot. 6. pp. 68–71, Feb., 1908.)—Puccianti, dealing with the structure of the arc [Abstract No. 2086 (1907)], completely confirmed Lenard's results, which pointed to the arc being arranged in layers and that each layer gives out definite radiations [Abstract No. 588 (1904)]. The author discusses the experiments, and concludes that the arc does not consist of a series of hollow flames, as Lenard supposed, but that the size of the spectral images obtained by Lenard's method varies with the intensity of the radiation. The arc cannot, therefore, be stratified, each stratum having a definite radiation, but must be of simple structure. E. C. C. B.

665. *Arc between Metal Electrodes.* **A. Grau** and **F. Russ.** (Phys. Zeitschr. 9. pp. 107–109, Feb. 1, 1908.)—This paper describes experiments on the p.d. between metal electrodes for a direct-current arc. Previous work has been done by Guye and Zébrikoff [see Abstract No. 1557 (1907)] and by Mrs. Ayrton. In the present research the electrodes were of copper, 18 mm. and 12 mm. diam. respectively, and were water-cooled. The arc was enclosed in a fused quartz tube 2 cm. diam. and 12 cm. long, and the combustion products were removed by a pump. The results are given in the following table:—

Arc Length.	1 cm.	2 cm.	3 cm.	4 cm.	5 cm.
Amps.	Volts.	Volts.	Volts.	Volts.	Volts.
4	90	125	160	195	—
5	85·5	116	146·5	177	208
6	82·5	110	137·5	165	192·5
7	80	105·5	131	156·5	181·5
8	—	102·5	126	150	174
9	—	100	122	145	167·5
10	—	—	119·5	141	162·5

These results are discussed, use being made of Mrs. Ayrton's formula for the potential between the electrodes. (Ibid. p. 176. *Errata.*) [See also Abstract No. 1429 (1907).] A. W.

666. *Dynamo for Electric Oscillations.* **O. M. Corbino.** (Elettricista, Rome, 7. pp. 1–2, Jan. 1, 1908. Phys. Zeitschr. 9. pp. 193–195, March 15, 1908.)—The best model of a small dynamo for electric oscillations consists of a drum armature with very thin sheet-iron discs, cut in the direction of two perpendicular diameters. The cylindrical armature has a diam. of 62 mm. and a length of 65 mm. The winding is such that each turn embraces 7/16ths of the entire circumference. The total resistance of the armature is 3 ohms, and the whole machine has an inductance of 90 millihenrys. The machine gives a maximum of 250 ∾ per sec. This cannot be exceeded unless iron is altogether eliminated from the construction, for at any higher speeds the negative resistance of the dynamo is compensated by its apparent positive resistance, and the oscillations are damped out of existence. A dynamo without iron would require a peripheral speed of 60 m. per sec. If the structural difficulties can be overcome, there is no theoretical limit to the frequency of oscillations attainable. E. E. F.

667. *The Electric Arc in an Enclosed Space.* **A. Minet.** (Comptes Rendus, 146. pp. 467–470, March 2, 1908.)—A cylindrical hole was bored through a block of magnesia, and an electric arc was started in this cavity.

When the current was kept constant and the length l varied, it was found that $E = e + \epsilon l$, where E is the applied voltage, e the counter-e.m.f. which varied from 14 to 18 volts, and ϵ the p.d. per cm. length of the arc. It follows that $EC = eC + \epsilon Cl$. Assuming that the heat ϵCl is conducted away by the walls in contact with the arc, the author is led to suppose that the current may be expressed by $k_1 d^{3/2}$, where k_1 is a constant and d the diam. of the cylinder in cm. He finds that $k_1 = 11{\cdot}17$ when $c = 34$ and $d = 2{\cdot}1$. The current density δ is given by $k_2/d^{1/2}$, where $k_2 = 4k_1/\pi = 14{\cdot}22$. The p.d. per unit length of arc is $\epsilon = 8{\cdot}7/d^{1/2}$. If ρ be the volume resistivity of the arc and δ the current density, $\epsilon = \rho\delta$, and thus $\rho = 0{\cdot}61$ ohm. Assuming the applied p.d. to be 64 volts, and that e is 14, we get $l = 5{\cdot}75 d^{1/2}$. The heat loss per sec. through unit area of enclosure is $\epsilon C/\pi d$, that is, 31 joules. When d is 1·5, 2·1, 3·1, and 4·1 cm. respectively, the experimental results agree well with the calculated values, but when d is 1·1 the agreement is not so good. A. R.

668. *Use of the Mercury Vapour Gap for producing slightly damped Oscillations.* **B. Glatzel.** (Deutsch. Phys. Gesell., Verh. 10. 3. pp. 54–66, Feb. 15, 1908.)—The author points out that by the employment of the mercury vapour gap, a method of producing slightly damped oscillations by means of a sort of impact effect is possible. In this method the primary circuit is arranged to have its oscillations so strongly damped (by transference of the energy to its secondary) that the spark ceases after the first quarter-period. The oscillations in the secondary—which is arranged so as to have very small damping, and has the greater part of the primary energy transferred to it during the latter's first quarter-period—then continue alone for a considerable time owing to the small damping, and are quite unaffected by the primary, since the oscillations in the latter have long since died out [see Wien, Abstract No. 2076 (1906)]. The arrangements employed are then described and resonance curves given for the mercury vapour gap and for a spark-gap between zinc electrodes in air. A special modified form of electrode for the mercury vapour lamp is described, and also a method of reducing the discharge p.d. of such a gap. This latter method consists in charging two slit rings of metal, surrounding the mercury electrode, to an equal but opposite potential to that of the electrode which it surrounds (p.d. reduced in ratio 25 : 42). Experiments on the effect of blowing away the ionised air from the neighbourhood of the spark (in air) by means of a blast of CO_2 are also briefly referred to. [See also Abstract No. 453 (1908)].
L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

669. *Present State of the Controversy concerning the Origin of Electrification by Contact.* **N. A. Gezechus [Hesehus.]** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 39. No. 2. pp. 37–42, 1907.)—The present state of our knowledge points to the chemical theory of electrification by contact being the correct one. This is due principally to the experiments of Spiers [Abstract No. 514 (1900)], Brown [Abstract No. 151 (1904)], and Greinacher [Abstract No. 1641 (1905)], who showed that heating annuls the p.d. between two metallic discs in contact, from which it is concluded that the layer of condensed water vapour on the surfaces of the metals plays the essential part in electrification by contact. The chemical theory cannot, however, explain the contact electrification of two chemically identical bodies differing only in the degree to which their surfaces are polished; as a general rule, the more highly

polished surface becomes positively electrified. Further, increase of the thickness of the moist layer—for example, by breathing on it—should not essentially alter the electrification, but experience shows that the sign of the electrification is changed in this way. The various phenomena of electrification are now readily explained by the electron theory, which should settle the dispute between the followers of the contact and chemical theories.

T. H. P.

670. *Thermo-electricity and Contact Electricity.* **N. A. Gezechus [Hesehus].** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 39. No. 1. pp. 1–9, 1907.)—In Volta's contact series, the metals sodium and potassium are placed at the positive end, whilst in the thermoelectric series these metals are at the negative extremity. The cause of this difference in position lies in the magnitude of the coefficients of expansion of the metals. On the other hand, selenium and tellurium are at the negative end of Volta's series, and at the positive end of the thermoelectric series; in this case, the difference in position in the two series lies in the values of the thermal coefficients of the electrical conductivity, which are positive for Se and Te and negative for the metals. Thermo-electricity is a complicated phenomenon as, in addition to contact electrification, it is due to the e.m.f.'s generated in each of the two metals by heating. These e.m.f.'s according to Rozing (Ibid. 30. pp. 102 and 151, 1898), and Egg-Sieberg [Abstract 2215 (1900)], give rise to currents directed, in Sb, Cd, Zn, Ag, Cu, and brass, from the warm towards the cool part, and in Sn, Al, Pt, Fe, Bi, and Pd in the opposite sense; in lead, the e.m.f. is zero. Two causes here act one against the other. Firstly, the negative electrons are directed from the more dense or cold to the less dense or warm part; secondly, the heating increases the number of free ions and induces a movement of the negative electrons towards the cold part. In some cases the first of these causes predominates, in other cases, the second, whilst with lead the two causes are in equilibrium. The neutral temperatures of the thermoelectric couples formed by any metal, say Fe, with Cd, Zn, Ag, Cu, Au, Pb, Al, Sn, Pt, and Pd, rise successively (from 160° to 1,908° for iron). On the other hand, the e.m.f.'s due to the difference of temperature in each metal of this series fall from positive values to negative values, being zero for lead.

T. H. P.

671. *Conductivity of Selenium.* **G. Athanasiadis.** (Ann. d. Physik, 25. 1. pp. 92–98, Jan. 17, 1908.)—Not only light, but also heat, Röntgen and radium rays, and admixtures of barium carbonate, hydrogen peroxide, turpentine, and the alcoholic solutions of some pigments, reduce the resistance of selenium [see Abstracts Nos. 1494 (1901), 1438 (1903), and 614 (1904)]. According to Hopius, the conductivity of selenium is proportional to the cube root of the illumination. Hesehus, on the other hand [Abstract No. 613 (1904)], connects the illumination i with the conductivity m by means of the formula $i = a(b^m - 1)$. The author's experiments show that neither of these formulæ is to be trusted. He puts forward the formula $i = K(K - a)b$, where K is the conductivity. This formula applies to all colours, except that the numerical values of the constants a and b change. Selenium is most sensitive to red light of wave-length 700 $\mu\mu$. When placed in the dark after illumination, selenium only gradually attains its original resistance. The whole process usually requires 50 to 60 hours. Shock is capable of lowering the resistance.

E. E. F.

672. *Relationship between Electrical Conductivity and Temperature.* **E. Rasch and F. W. Hinrichsen.** (Zeitschr. Elektrochem. 14. pp. 41–46, Jan. 31, 1908. Communication from the Kgl. Materialprüfungsamt, Gross-Lichterfelde.)—It is suggested that the influence of temperature on the conductivity of a badly conducting material (galena, tin, stone, &c.) may be represented by van't Hoff's equation $dK/K = NdT/T^2$, where $K =$ conductivity, $T =$ temperature, $N =$ a constant, probably a heat-quantity. This gives $\log K = -N/T + C$, *i.e.*, the logarithm of the conductivity is a linear function of the reciprocal of the temperature. In this equation C is evidently the logarithm of the conductivity at an infinitely high temperature. The linear relationship is shown to exist within narrow limits in the case of antimony chloride, $SbCl_3$, between 100° and 210° C., for three kinds of glass between 200° and 350°, for porcelain (with slight deviation at the lower temperatures) between 50° and 210°, for linseed oil between 33° and 135°, for water and ice with a break at the freezing-point, for arc-light electrodes between 705° and 1,260°, and for electrodes made of zirconium and yttrium oxides. T. M. L.

673. *An Electric Method of Measuring.* **A. Guillet.** (Comptes Rendus, 146. pp. 465–467, March 2, 1908. Lumière Électr. 1. pp. 408–409, March 28, 1908.)—Two coils A, B are placed near one another, and another coil C is placed coaxially between them. A and B are in series and carry a current, say 0·3 amp., alternating, say, 10 times a second. C is in circuit with a delicate galvanometer. Suppose that C is displaced a small amount, say 0·001 mm. towards A, from a central position between A and B. The mutual potential of C–A increases and that of C–B decreases, and since A and B produce opposite induction in C, there will be a net current in C which will be indicated on the galvanometer. Thus to measure a small movement, say, in a rod expanding thermally, connect it to C; any displacement will produce a deflection in the galvanometer and the deflection gives a measure of the movement. Obviously the apparatus can be made very sensitive by suitably arranging the size and distance of the coils or the sensitiveness of the galvanometer. P. E. S.

674. *Resistance of Stressed Nickel.* **G. Ercolini.** (N. Cimento, 14. pp. 537–564, Dec., 1907.)—Nickel offers the unique advantage that its resistance diminishes at first under tension. This effect is contrary to that which might be expected from its geometrical alteration in shape, and is therefore free from objection on that score. The author has therefore subjected the metal to a protracted series of deformations, including extension, torsion, flexure, and combinations of these. He finds that the changes of resistance produced by the various deformations depend upon the time which has elapsed since the application of the force, but tend towards a value which becomes constant after the lapse of a certain time. The resistance of crude nickel under tension decreases at first, and then (under 1 kg. for a wire 0·24 mm. in diam.) increases. The same cycle is passed through on release, with a slight lag. The permanent lowering of the resistance by the "accommodation" of the wire requires a large number of cycles. The behaviour of annealed wires is nearly the same, except that the moment of release is marked by a slight increase in resistance in crude nickel, and not in annealed nickel. A long repetition of the cycle leads to a permanent increase of resistance, instead of a decrease. Torsion increases the resistance of crude nickel in general. On release the resistance falls again, and finally reaches a value lower than the initial value. A very small torsion produces a decrease of resistance. A continuous increase of torsion does not produce an equally continuous increase in the resistance. The molecular structure seems to give way now and then and assume new states of equilibrium. In annealed wires the increase of resistance passes through a minimum, after which the wire stretches considerably and the resistance increases more rapidly with further torsion. Simultaneous tension and torsion show a prevalence of the tension effects over the torsion effects. The effects are not simply superposed, and one retards the other. If a crude wire is considerably twisted, and a tension is added, its effect is the reverse of the ordinary. Release always diminishes the resistance, but not in annealed wires. The variation of resistance on bending depends upon the weight to which the wire is subjected. If great, the resistance increases at each bending; if small, the first bending increases the resistance, but every subsequent bending annuls part of the effect of the first. E. E. F.

675. *Measurement of Self-inductance.* **E. Giebe.** (Ann. d. Physik, 24. 5. pp. 941–959, Dec. 31, 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—In the usual Maxwell bridge for the comparison of self-inductances, the two non-inductive arms are formed by a stretched slide-wire, and it is usually necessary to connect non-inductively wound additional resistances in series with the slide-wire if fair sensitivity is desired. In so doing it is generally taken for granted (at least when the values of the self-inductances to be compared are high) that the small self-induction of the straight slide-wire and of the supplementary resistances are negligible. The author shows that this is not so on unsymmetrical bridges with alternating currents of high frequency, and utilises the fact for the measurement of very small self-inductances, the values derived being dependent on the calculated self-inductance of a pair of parallel wires.

F. E. S.

676. *Mutual Inductance Coefficients.* **D. N. Mallik.** (Phil. Mag. 15. pp. 364–371, March, 1908.)—The expression for the mutual potential energy M, between any two magnetic shells may be written in the form—

$$M = \psi\psi' \iint \frac{\partial}{\partial n} \cdot \frac{\partial}{\partial n'} \left(\frac{1}{\rho}\right) ds \,.\, ds',$$

when ψ, ψ' are the magnetic strength of the shells, ds, ds' elements of the surfaces of the shells, ρ the distance between them and dn, dn' elements of outward-drawn normals. Using the corresponding expression in electrodynamics the author readily finds expressions for the mutual inductance between two circles of wire in any relative position; between two parallel rectangular wires; and between two concentric and coplanar elliptic wires.

A. R.

677. *The Self-inductance of a Cylindrical Coil.* **E. B. Rosa.** (Bureau of Standards, Bull. 4. pp. 369–381, Jan., 1908. Lumière Électr. 1. pp. 78–80, April 18, 1908. Abstract.)—The author considers three self-inductances L_s, L_u, and L. L_s is the first approximation to the self-inductance required and can be readily found by Lorenz's current-sheet formula which is readily evaluated as it only contains complete elliptic integrals. This formula supposes that the depth of the winding is zero. L_u is the self-inductance of a coil of the same dimensions and having the same number of turns but having a depth t. The current is now supposed to be uniformly distributed over the cross-section of the winding as though the wire were of a square section and had only an infinitesimal covering. L_u is calculated by means of L_n, and tables to assist in this calculation are given in this paper. The true value of L is then found from the formula $L = L_u + \Delta_2 L$, where $\Delta_2 L$ is the sum of three terms the values of which can be found. The correcting factor $\Delta_2 L$ can be neglected except when a high accuracy is desired. Its value has previously been fully discussed [Ibid. 3. pp. 3, 4, 28–37; Abstract No. 1185 (1907)]. Three numerical examples are fully worked out. A coil of this nature is not recommended for a standard of the highest precision. A. R.

678. *Bessel Integrals and the Mutual Inductances of Coaxial Coils.* **T. H. Havelock.** (Phil. Mag. 15. pp. 332–345, March, 1908.)—The author shows how the mutual inductance coefficients of coaxial coils can be found in terms of Bessel integrals. He converts these integrals into series from which the inductance coefficients can be readily calculated. He also gives a list of integrals involving Bessel functions which will be helpful to the physicist. For the mutual inductance M, of a short helical coil of radius a and length $2h_1$ inside a long coil of radius b and length $2h_2$ he finds the following useful series—

$$M/8\pi^2a^2n_1n_2 = h_1 - b^2\left\{\frac{1}{4}(u-v) - \frac{1}{16}d(u^3-v^3)\right.$$
$$\left. + \frac{1}{32}(c^2+d^2)(u^5-v^5) - \frac{5}{256}d(3c^2+d^2)(u^7-v^7) + \dots\right\},$$

where $c = ab$, $d = a^2 + b^2$, $u = 1/(h_2 - h_1)$ and $v = 1/(h_2 + h_1)$. He applies this to a numerical example and finds that it gives practically the same result as the formulæ given by Roiti, Searle and Airey, and Russell. He also finds the following expression for the self-inductance L, of a long solenoid of radius a and length $2h$—

$$L = 2\pi^3\frac{a^2N^2}{h}\left\{1 - \frac{4}{3\pi}\frac{a}{h}\right.$$
$$\left. + \sum_0^\infty(-)^s\frac{(2s)!\,(2s+2)!}{2^{4s+3}s!\,(s+2)!\,[(s+1)!]^2}\left(\frac{a}{h}\right)^{2s+2}\right\}$$
$$= 2\pi^2a^2N^2\left\{1 - \frac{4}{3\pi}\frac{a}{h} + \frac{1}{8}\left(\frac{a}{h}\right)^2 - \frac{1}{2^6}\left(\frac{a}{h}\right)^4 + \frac{5}{2^{10}}\left(\frac{a}{h}\right)^6 - \dots\right\}.$$

When h is greater than a this series converges very rapidly. Russell [see Abstract No. 1210 (1907)] has previously deduced the first four terms of this series from the elliptic integral formula. A. R.

679. *Electrolytic Interrupters.* **P. Ludewig.** (Ann. d. Physik, 25. 3. pp. 467–505, March 3, 1908. Extract from Dissertation, Göttingen.)—Discusses the theories of Wehnelt [Abstract No. 1521 (1899)] and Simon [Abstracts Nos. 1520 and 1919 (1899)]. Simon's theory turns out to be applicable to the hole interrupter. The author enlarges the theory so as to include changes of pressure and temperature, and confirms the extended theory experimentally. Simon's theory does not apply to Wehnelt's point interrupter, since the pure heat-effect is complicated by electrolytic production of gases. Neither is the process explained by Klupathy's theory, who finds the chief cause of interruption in the Peltier heat developed at the junction of platinum and sulphuric acid. The author does not succeed in formulating any mathematical theory of the point interrupter. Among attempts to account for the unipolar character of the discharge that of Stark and Cassuto deserves preference. It is a case of arc-formation. The use of electrolytic interrupters with induction coils produces a characteristic change in the current curves. The point interrupter shows a greater inductance at make than does the hole interrupter, and the latter is therefore more useful for Röntgen-ray work. E. E. F.

680. *Quadrant Electrometer.* **L. Malclès.** (Soc. Franç. Phys., Bull. No. 8. pp. 285-287, 1907.)—A new type is described, which has a low sensitiveness but is strong and portable. The needle is of mica covered with Al-foil 0·01 mm. thick, and is suspended by a silver wire 0·04 mm. thick. The damping arrangement is novel. It consists of a disc of mica suspended below the needle, with its plane horizontal. It oscillates above a metallic plate fixed at a distance of the order of 1 mm., but adjustable to various distances. The viscosity of the air provides the damping action. E. E. F.

681. *Potentiometer for Use with Cadmium Cell.* **H. Diesselhorst.** (Zeitschr. Instrumentenk. 28. pp. 38-40, Feb., 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—The potentiometer consists of a resistance of 10,200 ohms which may be shunted so as to make the joint resistance 1,020, 102, or 10·2 ohms. The resistance of 10,200 ohms is in three parts, the first of these being a coil of 10,180 ohms, the middle portion a uniform wire of 10 ohms, and finally a resistance coil of 10 ohms. The e.m.f. of a cadmium cell may thus be balanced against the p.d. of any part of this main resistance extending from 10,180 to 10,190 ohms. Since the e.m.f. of a cadmium cell is nominally 1·018 volts the normal current through the main resistance is 0·0001 amp., but by the aid of the shunts, currents of 0·001, 0·01, and 0·1 amp. can be used in the circuit external to the potentiometer. F. E. S.

ALTERNATING CURRENTS AND MAGNETISM.

682. *The Demagnetisation of Iron.* **C. W. Burrows.** (Bureau of Standards, Bull. 4. pp. 205-274, Jan., 1908.)—The paper contains a number of curves and tables illustrating the behaviour of previously magnetised iron of various qualities under the action of demagnetising forces applied in various ways from a series of slow reversals up to reversals occurring at a frequency of 900 per sec. The object of the research was to ascertain the best way of demagnetising specimens of iron prior to ballistic measurement. With slow reversals demagnetisation of a previously magnetised specimen is complete if the maximum value of the demagnetising force is greater than a certain "critical demagnetising force." This "critical demagnetising force" is equal to a magnetising force H, which is just above that corresponding to the point of maximum permeability. The final value to which the demagnetising force should be reduced must be lower than that of the magnetising force to be used in the ballistic measurement. As the frequency of reversal is raised, the demagnetisation becomes less and less complete, owing to the effect of eddy currents shielding the internal portions of the specimen. Various other points were investigated, and the following procedure prior to ballistic measurement is recommended : The magnetic system, consisting of

test-pieces and connecting yokes, should be mounted with its plane perpendicular to the earth's field, and protected from mechanical vibration. If an accuracy of 1 per cent. in the steep part of the B-H curve is desired, the temperature of the specimen should be kept to within 1° or 2° of some standard temperature (*e.g.*, 20° C.). Demagnetisation should be accomplished by reversals at the rate of 1 per sec. The initial demagnetising current should be sufficient to carry the induction beyond the knee of the B-H curve ; the final current should not be greater than the smallest value of the magnetising current to be used, and between these values the demagnetising current should preferably be reduced in such a way that the rate of reduction of B is roughly constant. Full demagnetisation may be accomplished in about 90 sec. Now apply the lowest magnetising force desired and reverse at the same speed as in demagnetising. At intervals get a ballistic deflection. Continue this until two deflections about 25 reversals apart show only a negligible difference. This final deflection is the normal induction. Without demagnetising, again apply the larger magnetising force and proceed as before. J. D. C.

683. *Effect of Treatment upon Heusler Magnetic Alloys.* **P. Asteroth.** (Deutsch. Phys. Gesell., Verh. 10. 2. pp. 21–32, Jan. 30, 1908. Extract from Inaug.-Dissertation, Marburg, June 11, 1907.)—Experiments on an alloy of copper containing Mn 16·9 per cent. and Al 9 per cent. show that the slower the rate of cooling through the transformation (about 195° for the cast and 220° for the forged alloy) the greater are residual magnetism, coercive force, and the area of the hysteresis loop. This alloy is malleable, and after forging at a red heat, annealing, and quenching in water the corresponding values were always much lower than for the cast metal. The following table exemplifies these properties. H and H_0 are in gauss, B and B_0 in absolute units.

Treatment.	Cast.			Forged.		
	B for H = 150.	H_0.	B_0.	B for H = 150.	H_0.	B_0.
Original condition	—	—	—	1,130	—	—
Long heating at 140°	3,190	—	—	2,800	—	—
Quenched in water from above critical point, and aged at 140°	2,300	3·0	650	2,500	—	—
Ditto, higher initial temperature	—	—	—	2,100	0·29	10
Cooled in ¾ hour from above critical point, aged at 140°	2,200	10·0	700	2,480	2·0	650
Cooled in 3 hours from above critical point, aged at 140°	2,200	18·0	820	2,500	3·5	600
Quenched in mercury from above critical point, aged at 140°	—	—	—	2,000	0·1	9·25

In the case of an alloy containing Mn 26·5, and Al 14·6 per cent. the changes were but very slightly marked. The attempt to explain the results proceeds on the familiar conceptions of molecular magnets and friction. It is proposed to investigate whether there be a parallel between hysteretic and elastic after-effect, and to employ alloys of low hysteresis in investigations in which it is desirable to eliminate a further dependent variable in a reversible process. F. R.

684. *Variation of Resistance of Iron with Magnetisation.* **M. Dumermuth.** (Lumière Électr. 1. pp. 121–123, Jan. 25, 1908.)—Five thousand turns

of iron wire 0·26 mm. in diam. formed a ring of about 30·6 cm. in diam. and had a resistance at 0° C. of 8,717 ohms. This test-piece was encircled by a primary and secondary and the magnetic properties were determined by the ballistic method. For the measurement of resistance the coil was placed in one arm of a Wheatstone bridge, and to avoid as much as possible the variations of resistance accompanying changes of temperature, the ring was kept at the temperature of melting ice. The following table gives the values of H and the corresponding increase in resistance. On reversal of the current practically the same results were obtained.

H (gauss).	Increase in Resistance.	H (gauss).	Increase in Resistance.
5·6	0·055 ohms	32	2·752 ohms
7·20	0·206 „	40	3·645 „
8·80	0·258 „	48	4·365 „
10·4	0·402 „	56	5·022 „
12	0·553 „	64	5·562 „
13·6	0·747 „	80	6·605 „
14·4	0·868 „	100	7·709 „
16	1·023 „	120	8·796 „
20	1·46 „	140	9·702 „
24	1·84 „	160	10·63 „

F. E. S.

685. *Magnetic Properties at Low Temperatures.* **J. Stauber.** (Lumière Électr. 1. pp. 120–121, Jan. 25, 1908. Thèse de doctorat, Zurich, 1906.)—Three samples of steel were experimented with at temperatures approximating to 20°, 0°, —32°, —70°, and —180° C., the magnetic properties being determined by the ballistic method. The samples consisted of a number of thin sheets in the form of rings, bound together, and between 20° and —70° C. the temperature was obtained from the resistance of a copper coil encircling the steel ring. The results show very clearly that the lowering of temperature is accompanied by a decrease in the permeability when weak fields are employed. If the permeability at a temperature t be represented by μ_t, then the value of $(\mu_{20} - \mu_t)/\mu_{20}$ is shown to be a maximum for that value of the field corresponding very nearly to the abscissa of the first point of inflection of the curve $\mu = f(\mathrm{H})$. When the magnetising field was considerably increased (up to 30 gauss) a very small increase in the permeability was noted on diminishing the temperature. F. E. S.

686. *Comparative Determinations of the Horizontal Intensity at Potsdam and at Cheltenham in* 1904. **F. Linke.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 5. pp. 582–588, 1907.)—By modifying the formula of Lamont for log H, the author arrives at a formula of four terms, the three last of which are easily determined, whilst the first, log C, is constant for a given theodolite and magnet. The determination of C requires apparatus which are not to be found in all stations. When a "relative" theodolite is used, however, the C can be found by comparison with the theodolite of a larger observatory. Small stations then only need a simpler and less expensive instrument, such as the magnalium-theodolite of the Eschenhagen-Edler type, which Tesdorpf, of Stuttgart, made for Bidlingmeyer's observations during the German South Polar Expedition of 1901–3. This instrument kept very constant there, and afterwards, in spite of rough treatment on the journey, at the Apia Observatory (Samoa). Taking 4 complete sets of observations of the horizontal intensity at Potsdam, 8 at Cheltenham, and 8 more at Potsdam, the author found the figures of the sets concordant, but the Cheltenham intensity proved smaller than the Potsdam intensity by 85γ. Other comparative measurements conducted at Apia with the same theodolite and the Cheltenham instrument (Kew pattern) of the survey ship *Galilee* of the Carnegie Institution again gave a difference of 84γ. The difference seems hence to be real, and such comparisons would be needed from time to time. "Relative" theodolites would suffice for this purpose ; smaller observatories should indeed leave the absolute determination of the constants to the chief observatories, which latter should apply several different methods.

H. B.

687. *New Magneto-elastic Detector.* **A. G. Rossi.** (N. Cimento, 15. pp. 63–65, Jan., 1908.)—A wire of iron or nickel 0·1 mm. thick and 20 or 25 cm. long is traversed by a feeble alternating current. It is subjected to tension, and at the same time to a magnetic field which diverges from its centre towards both its ends. The result is that the wire undergoes a periodical torsion, which is greatest in the centre, and this torsion is read and registered by means of a small mirror attached to the centre of the wire. The magnetic field is provided by two small bar magnets having both their N-poles near the centre of the wire, and the sine-current is furnished by a small magneto-electric machine. The receiving antenna communicates with two coils surrounding the upper and lower portions of the stretched wire, and the current received traverses these two coils from the centre of the wire outwards. It has the effect of reducing the amplitude of oscillation of the mirror, and the track described by a spot of light reflected from it is shortened. This affords a ready means of observation and of photographic recording.

E. E. F.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

688. *Theory of Galvanic Polarisation : Calculation of Stimulating Action of Electrical Currents.* **W. Nernst.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 1. pp. 3–18, 1908.)—The alterations in concentration which occur at the limiting surface of two solvents, which are not miscible with each other, in consequence of electrolytic migration, are, as the author has previously pointed out (Gesell. Wiss. Göttingen, Nachr. p. 104, 1899), in all probability responsible for certain physiological processes. After deducing the differential equations which hold for certain limiting cases, the author gives several applications. Assuming that the maximum stimulating effect is attained when a concentration difference $A = C - C_0$ is caused by the current at the boundary surface of the protoplasm, equations are developed for the action of alternating currents and for the stimulating effect of constant currents. These equations are simple, and can be tested experimentally. The experiments of Zeynek, Nernst and Barratt, and Reiss have verified the theory for alternating currents. Weiss has carried out experiments with constant currents [Abstract No. 1701 (1901)], and from his data has deduced a formula for the amount of stimulation. These experiments also agree with the formula of the author, as also do those of Lapicque [Abstract No. 882 (1904)], whereas Weiss's formula does not hold in the latter case. [See also Abstract No. 707 (1899).]

T. S. P.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

689. *Decomposition of Complex Chemical Compounds in an Oscillatory Magnetic Field.* **J. Rosenthal.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 1. pp. 20–26, 1908.)—A number of complex optically-active compounds were exposed to an alternating magnetic field. It was found that with a definite periodicity hydrolysis occurred of the same character as that produced by enzymes. Thus, with a frequency of 440 to 480 periods per sec. starch-paste became liquefied, and was ultimately resolved into a clear liquid in which the starch iodide reaction could no longer be observed. Proteins were resolved into albumoses and peptones, with a lower frequency of 320 to 360 periods per sec., but a much higher frequency was required in the case of simpler compounds such as the glucosides, disaccharoses, &c. That the effects observed are not due to secondary electrical actions (*e.g.*, eddy currents in the solution producing electrolysis) is shown by the fact that when the frequency is altered or is made irregular the liquid is merely heated, and the special chemical changes noted above are not produced. Attention is called to the relationship between magnetic field and rotation of the plane of polarisation as observed by Faraday, and to the fact that all the substances investigated possessed a natural optical activity. T. M. L.

690. *The Absorption Coefficient of Radium Emanation in Solutions and Mixtures.* **M. Kofler.** (Phys. Zeitschr. 9. pp. 6–8, Jan. 1, 1908. Physikal. Inst. der k.k. Univ., Innsbruck.)—The object of the investigation described was to determine the magnitude of the absorption coefficient of radium emanation in solutions and mixtures, and to find the connection between it and the concentration. The value of the absorption coefficient α is expressed by the following relation: $\alpha = (E_f/E_l)(V_l/V_f)$, where E_f and E_l are the amounts of emanation relating to liquid and air and corresponding to the volumes V_f and V_l respectively. The values of the coefficient α and the specific weight of various salts are expressed in a table, and it appears that for all salts there is a decrease of the absorption capacity with increasing concentration of the solution. The absorption coefficient increases with rise in the value of the molecular weight of the salt. The behaviour in this respect may be described by the statement: The absorption coefficient decreases, as well for one and the same salt as also for various salts, with increasing number of dissolved molecules. Accordingly it is not excluded that the absorption coefficients of equivalent solutions of various salts are equal to one another. The value of the absorption coefficient for distilled water found by the author, $\alpha = 0{\cdot}270$, agrees well with the number previously stated by Hofmann. The connection of the absorption coefficient with the concentration of a mixture was investigated in the case of alcohol. As the specific weight of the mixture decreases so its absorption capacity rises, and the more rapidly the further the concentration has already advanced. The value of the absorption coefficient of sea-water is of some interest. At 18° C., and with a specific weight of 1·028, the value is 0·165. The absorption capacity of sea-water is thus significantly less than that of distilled water at the same temperature. J. J. S.

691. *Permeabilities of Collodion, Gold-beater's Skin, Parchment Paper, and Porcelain Membranes.* **S. L. Bigelow.** (Amer. Chem. Soc., Journ. 29. pp. 1675–1692, Dec., 1907.)—With a view to throwing light on osmotic phenomena, measurements were made of the permeability of the four types of membrane under different pressures and at different temperatures. The most important result achieved was to show that Poiseuille's laws for the passage of liquids through capillary tubes apply to the passage of water, not only through unglazed porcelain, but also through the other three membranes. The behaviour of membranes is therefore identical, whether the liquid passes through actual pores or merely through molecular interstices. The paper includes some remarkable quotations from Lhermite's "Recherches sur l'Endosmose," which show that this writer, as long ago as 1855, stated with absolute clearness the modern "solution" theory of semi-permeable membranes, and advocated the view that chemical affinity and physical affinity were essentially one, so that one "might consider capillary force as the first degree of chemical affinity." T. M. L.

692. *Laboratory Arc Furnace.* **L. Clerc** and **A. Minet.** (Comptes Rendus, 146. pp. 227–229, Feb. 3, 1908. Lumière Électr. 1. pp. 247–248, Feb. 22, 1908.)—An arc of any desired length may be maintained in the interior of a block of lime or magnesia in a cavity whose cross-section varies as some power (greater than unity) of the length of arc, by varying the current as a power (less than unity) of the section [see Abstract No. 667 (1908)]. The temperature of the arc is sensibly constant. An arc several cm. in length can be maintained with 40 amps. at 60 volts. The furnace consists of a block of refractory material with a central vertical hole. The ends of the carbons enter this horizontally at the sides. After the establishment of the arc a crucible containing the substance to be operated on is raised upon a support of lime or magnesia to any position with respect to the arc. This has no notable effect upon the arc. With from 1 to 2 kw. the capacity is from 2 to 40 gm., according to the density of the substance operated upon. F. R.

693. *Artificial Corundum.* **O. Hönigschmid.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2b. pp. 1013–1017, July, 1907. From the Chem. Laborat. d. k.k. deutsch. Univ., Prag.)—The author finds that in Kühne's process for the preparation of crystallised boron, in which boron compounds are heated with aluminium and sulphur, the yield contains no crystallised boron whatever, but a considerable amount of amorphous boron. The principal product is crystalline alumina (artificial corundum), and small quantities of what is probably a boride of aluminium, whose composition is to be further investigated, are formed. F. R.

694. *Alloys of Nickel with Tin, Lead, Thallium, Bismuth, Chromium, Magnesium, Zinc, and Cadmium.* **G. Voss.** (Zeitschr. Anorg. Chem. 57. 1. pp. 34–71, Jan. 25, 1908. Metallograph. Communication from the Inst. f. anorgan. Chemie d. Univ., Göttingen.)—Gives thermal data and photomicrographs of the above eight series of alloys with the temperature-concentration diagrams for each series, based upon these observations. The temperatures of magnetic change are also given for the magnetic alloys in the series. The Sn-Ni series are miscible in the liquid state, with the exception of those containing from 3·5 to 18 per cent. and 26 to

45 per cent. Ni, which form two layers. In the solid state these alloys are composed of mixed crystals at the nickel end of the series (85 to 100 per cent. Ni) and eutectic at the tin end; the series also contains the compounds Ni_3Sn_2, Ni_3Sn, and Ni_4Sn. Various changes in the compounds at different temperatures are fully discussed. The alloys are found to be magnetic up to 88 per cent. Sn. The Pb-Ni alloys are miscible in the liquid state between 0 to 16 and 72 to 100 per cent. Ni. Between 16 and 72 per cent. Ni two layers are formed. In the solid state these alloys consist of mixed crystals, 2 per cent. Pb in nickel, and lead in the free state. The alloys show magnetic properties from 100 down to 10 per cent. Ni. The Tl-Ni series form two layers in the liquid state up to 90 per cent. Ni. From 97 to 100 per cent. Ni the alloys are homogeneous. The Bi-Ni series are miscible throughout in the liquid state, and during solidification and cooling the compounds $NiBi_3$ and NiBi are formed. Saturated mixed crystals in the solid state contain 0·5 per cent. Bi in Ni. The Ni-Cr series are miscible in all proportions in the fluid state, and form two types of mixed crystals, Ni-rich and Cr-rich respectively, the curve showing a minimum point with 42 per cent. Ni at about 1,290°. The Ni-Mg series are miscible in all proportions in the liquid state, the solid alloys being composed of compounds and eutectics. The compound Ni_2Mg separates out at 1,145°, and at 768° this compound reacts with the still molten portion (in alloys containing from 45 to 88 per cent. Ni) to form the compound $NiMg_2$. There are no mixed crystals in these alloys when solid. The Zn-Ni and Cd-Ni series were examined only up to 21 and 15 per cent. Ni respectively; up to these figures the metals were completely miscible in the liquid state, and the solid alloys contained the compounds $NiZn_3$ and $NiCd_4$. C. O. B.

695. *Alloys of Aluminium with Copper, Iron, Nickel, Cobalt, Lead and Cadium.* **A. G. C. Gwyer.** (Zeitschr. Anorg. Chem. 57. 2. pp. 118–158, Feb. 15, 1908. Metallograph. Communication from the Inst. f. anorgan. Chemie d. Univ., Göttingen.)—The thermal analyses of these six sets of binary alloys are given with equilibrium diagrams and photomicrographs to illustrate the structure of the alloys. The Cu-Al alloys are miscible in all proportions in the liquid state. Between 100–91·5 per cent. Cu, 88·5–71 per cent. Cu, and 4–0 per cent. Cu the alloys consist of mixed crystals. From 91–88·5 per cent. Cu a mixture of mixed crystals is obtained with a eutectic-like structure; at 88·5 a minimum is obtained at 1,036°; between 88·5 and 87·5 per cent. Cu, a further mixture of mixed crystals is obtained, one of these consisting of a solid solution of Cu_3Al in Cu. At 87·5 per cent. Cu and 1,050°, the compound Cu_3Al is formed which crystallises in polyhedra. From 70–56 per cent. Cu mixed crystals of Cu_3Al and CuAl first separate, and these react with the still molten portion at 625° to form CuAl, and at 590° this compound again reacts with the molten portion to form $CuAl_2$. From 54–4 per cent. Cu the alloys are eutectiferous; the eutectic point, occurring at 32·5 per cent. Cu, consists of mixed crystals containing 4 per cent. Cu and the compound $CuAl_2$, and solidifies at 545°. The results obtained are compared with the former work of le Chatelier, Guillet, Campbell and Mathews, and Carpenter and Edwards. The Fe-Al series are also miscible in all proportions in the liquid state. In the research, an atmosphere of dry nitrogen was used to prevent oxidation. Mixed crystals are formed from 100–66 per cent. Fe and 48–40 per cent. Fe. The alloys containing over 70 per cent. Fe are magnetic. From 66–60 per cent. Fe, the alloys show two breaks, a eutectic being formed at 1,087°; the second break occurs at higher temperatures between 60–50 per cent. Fe. At

40·8 per cent. Fe the compound $FeAl_3$ is formed with a melting-point of 1,145°. From 40–0 per cent. Fe, the alloys are eutectiferous, the eutectic consisting of $FeAl_3$ and practically pure Al. The Ni-Al alloys are miscible in all proportions in the liquid state and form mixed crystals between 100–87·5 per cent. Ni and between 81–68·4 per cent. Ni; at the latter point NiAl is formed, having a maximum at 1,640°. Between 68–27 per cent. Ni, NiAl first separates and reacts with the still fluid portion at 1,130° to form $NiAl_2$. From 52–27 per cent. Ni, a further reaction takes place between this $NiAl_2$ and the fluid portion with the formation of $NiAl_3$. From 42–0 per cent. Ni, the alloys are eutectiferous, the eutectic point occurring with 6 per cent. Ni at 630° and consisting of $NiAl_3$ and pure Al. The Co-Al alloys are also miscible in all proportions in the fluid state, and form mixed crystals on solidifying, between 100–90·5 per cent. Co and 80–68·5 per cent. Co; the alloys between 90·5–80 per cent. Co are not homogeneous after heating for three hours at 1,250–1,270°. At 68·5 per cent. Co the compound CoAl forms with a maximum at 1,628°, and from 68–38 per cent. Co CoAl first separates and then reacts at 1,165°, with the still fluid portion to form Co_2Al_5. From 46·5–20 per cent. Co the compound Co_2Al_5 reacts, at 940°, with the still molten portion to form Co_3Al_{13}. From 33–0 per cent. Co the alloys are eutectiferous, the eutectic consisting of Co_3Al_{13} and pure Al, and solidifying at 644°. Lead and Al are not miscible in the fluid state, and between 5 and 99·5 per cent. Pb separate into two layers. Up to 5 per cent. Pb an emulsion is formed. Cadmium and Al are also not miscible in the fluid state, but form an emulsion up to 5 per cent. Cd. C. O. B.

696. *Phosphor-Bronze.* **E. S. Sperry.** (Mech. Eng. 21. pp. 54–55, Jan. 11, 1908. From "The Brass World.")—A general article. It is considered that the function of phosphorus in all usual phosphor-bronzes is only as deoxidiser and not as a constituent of the alloy. Phosphor-tin is the preferable means of adding the phosphorus; it generally contains about 5 per cent. of phosphorus. Phosphor-bronze intended to be rolled should be made from a mixture of tin 3 to 5, max. 8 per cent., phosphorus 0·02 to 0·03, max. 0·05 per cent. The following mixtures are recommended:—

	Copper.	Tin.	Lead.	5 Per Cent. Phosphor-Tin.
Springs	95	4½	0	½
Strongest Castings ...	90	9	0	1
Medium Castings	90	8	0	2
Bearings..................	80	8	10	2

Zinc has a bad effect in phosphor-bronzes, its presence being accompanied by the formation of "tin-spots" in a marked degree. F. R.

697. *Electrolysis of Solutions of Pure Hydrochloric Acid.* **E. Doumer.** (Comptes Rendus, 146. pp. 329–331, Feb. 17, 1908.)—In the electrolysis of solutions of HCl, some of the water is also decomposed, with evolution of oxygen together with the chlorine at the anode. This is due to direct electrolysis of water, and not to the action of nascent chlorine on the solution, since with anodes of Hg or Ag, which fix the chlorine, oxygen is still evolved. W. H. Si.